OUTFALL SYSTEMS PLANNING
FOR
LOWER DAD CLARK GULCH AND DFA 0068

ALTERNATIVE EVALUATION REPORT

Prepared For

THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

Prepared By

CENTENNIAL ENGINEERING, INC.
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UD&FCD 89-02.06
CEI - 906.00
April 1990

CENTENNIAL
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April 19, 1990

Mr. L. Scott Tucker, P.E.
Executive Director
Urban Drainage & Flood Control District
2480 W. 26th Avenue, Suite 156-B
Denver, CO 80211

Re: Lower Dad Clark Gulch
& DFA 0068 Outfall
Systems Planning
Agreement No. 89-02.06

Dear Mr. Tucker:

Centennial Engineering, Inc. is pleased to submit forty (40) copies of the Alternative Evaluation Report for the referenced project. The report presents improvement alternatives for Rangeview Gulch, Jackass Gulch and Lower Dad Clark Gulch. The alternatives are based on hydrologic and hydraulic considerations developed during the course of this study. The alternatives also address such issues as:

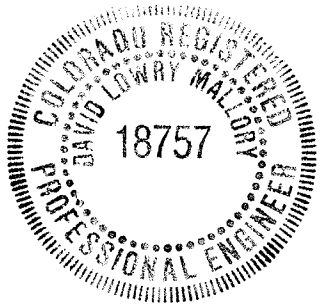
- Existing and future development.
- McLellan Reservoir
- Highline Canal
- City Ditch
- South Platte Park
- Ridgeview Park
- Future Santa Fe Drive, Railroad and RTD development.

The project sponsors and interested parties can now review the alternatives and select a plan for outfall system planning. We wish to thank the District and Littleton Staff for their input and assistance in completing the Alternative Evaluation Report. We look forward to working with you towards the completion of the remaining project tasks.

Sincerely,
CENTENNIAL ENGINEERING, INC.

PREPARED BY

David L. Mallory, P.E.
Project Manager



REVIEWED BY

Douglas C. Weber, P.E.
Chief Civil Engineer

Outfall Systems Planning
for
Lower Dad Clark Gulch and DFA0068

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INTRODUCTION

1.1 Authorization

The Urban Drainage and Flood Control District authorized this outfall planning study under Agreement No. 89-02.06 and the Notice to Proceed became effective on July 19, 1989 (the date which pencil manuscripts were received). The City of Littleton is also a project sponsor. The principle project goals are:

1. Formulate an outfall system plan for basins drained by Rangeview Gulch, Jackass Gulch, and Lower Dad Clark Gulch.

2. Interface the outfall system with the South Platte Park.

The study area is located almost entirely within the corporate limits of Littleton and covers approximately 2.6 square miles. It is located just north of County Line Road and is bounded on the east by South Broadway and on the west by the South Platte River. The Lee Gulch Basin is just to the north. Figure 1-1 shows the general location of the study area in the metropolitan region.

1.2 Scope of Work

The alternative evaluation phase of the outfall system planning includes the following tasks:

- Field reconnaissance.
- Compilation of existing data.
- Hydrologic analysis including flood routing.
- Development and evaluation of alternatives.

In evaluating each alternative, consideration was given to costs, existing and proposed land use, existing and proposed drainage systems, constructibility, maintenance needs, right-of-way needs, flood control, water quality impacts, and open space benefits.

1.3 Modifications to Scope

Modifications were made to the original scope of work due to complications which arose in the hydrologic analysis of McLellan Reservoir. The initial review of the background hydrology for Upper Dad Clark Gulch revealed that a 100-year composite inflow hydrograph for McLellan Reservoir was not available. Because of this, further evaluation and flood routing had to be done in order to obtain a composite hydrograph. In addition, inflow hydrographs were also computed for the 2-, 5-, 10-, and 50-year frequencies.

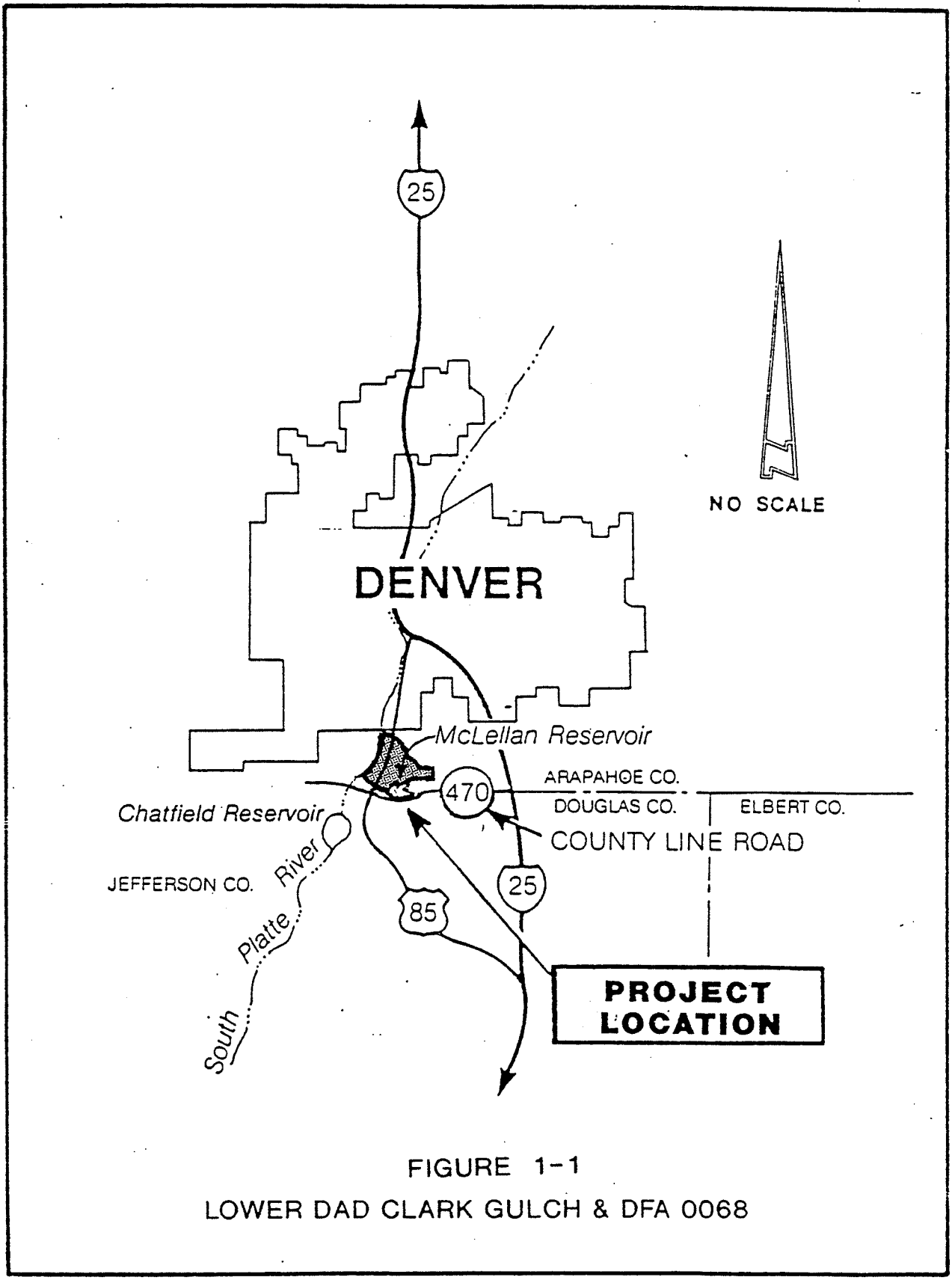


FIGURE 1-1

LOWER DAD CLARK GULCH & DFA 0068

1.4 Basin Descriptions

Some important features of the overall study area include:

1. Santa Fe Drive, the Denver & Rio Grande Western Railroad (D&RGW), and the Atchison, Topeka and Santa Fe Railroad (AT&SF): These features are located along side each other and run north and south through the study area. These features greatly influence the natural westerly drainage patterns.

2. City Ditch: The ditch (owned by Englewood) flows to the north and is located in the lower basin areas, mostly on the west side of Santa Fe Drive. In the future, the ditch is planned to be enclosed in a 60 inch pipe.

3. Highline Canal: This feature is owned and operated by the Denver Water Department and crosses the upper basins of Rangeview and Jackass Gulches. Drainage from the Rangeview basin upstream of the Highline Canal would normally flow across the canal into Rangeview Gulch. However, the development in the area directs the 100-year flow through a storm sewer system to the Jackass Gulch basin. Flows from the Upper Jackass basin cross the canal in a storm sewer system. Storm runoff from the South Park commercial area just south of the Upper Jackass basin is discharged into the Highline Canal through several onsite detention facilities. During the 100-year event, the total discharge from these facilities is approximately 550 cfs.

   Routine Highline Canal releases during rainfall events have caused local flooding in the Lee Gulch drainageway. From the Highline Canal Master Plan study done in 1975, the capacity of the canal between Lee Gulch and Little Dry Creek was found to be approximately 600 cfs. The portion of the Highline Canal which crosses the study area was assumed to have a similar capacity.

4. McLellan Reservoir: The reservoir is owned and operated by Englewood as a water supply facility and is located in the Dad Clark Gulch basin just north of County Line Road. Currently, it is not used as a flood control facility but could be if an adequate assurances agreement were signed.

The study area drains to the west toward the South Platte River, and each of the three major drainage basins (Rangeview, Jackass, and Lower Dad Clark) are served by existing drainage systems. The six direct flow areas do not have a significant drainage system. Records of previous flooding in the area are nonexistent.

The Rangeview Gulch basin is approximately 430 acres in size and is almost entirely residential. The drainage system in the upper basin (east of the railroad lines) is mostly open channel with numerous irrigation ponds. Both Ridgeview Park, which is located in the center of the basin, and Turtle Lake, which is just upstream of the railroad lines, could be used for flood control facilities. An existing 30" RCP storm sewer system is located in Curtice Street in the residential area between Ridgeview Park and Turtle Lake. However, during a major storm event, most flows will occupy the street. At Turtle Lake, low flows are intercepted by the City Ditch before they reach the lake. Flows which are discharged from Turtle Lake historically go directly to the South Platte River. However, due to the construction of the AT&SF Railroad embankment, these flows now go north along the east side of the railroad and discharge into Lee Gulch.

The Jackass Gulch basin is just south of Rangeview Gulch and is approximately 500 acres in size. It is an elongated basin extending from South Broadway to the South Platte River and is zoned almost entirely as a Planned Development (PD, PD-R, PD-C & PD-I). The upper basin (east of the Highline Canal) is mostly commercial with some residential. All of the existing developments in the upper basin have been designed to detain storm runoff for the 100-year event with private onsite detention facilities. The area between the Highline Canal and the railroad lines is zoned residential. The storm runoff system in this area consists of a natural channel with a municipal detention facility at the railroad lines. The lower basin (west of Santa Fe Drive) is a commercial area and has a 60" RCP storm outfall system which discharges into an open channel just upstream of the South Platte River. Currently, over half of the Jackass Gulch basin is undeveloped.

The Lower Dad Clark Gulch basin extends from the outfall of McLellan Reservoir to the South Platte River. The basin is approximately 290 acres in size and contains residential, commercial and industrial areas. Most of the basin is undeveloped at the present time. A portion of the South Park residential area is included in this basin. The drainage system is entirely open channel with bridge structures at the railroad and Santa Fe Drive crossings.

1.5 Background Information

A compilation of development drainage reports, utility information, construction plans, and other reference sources is listed in Appendix A. The availability of information for a specific area varied depending on the development. Two areas did not have much background information -- Rangeview Basin, which is an older development, and the Santa Fe Park area (between Santa Fe Drive and the South Platte River) which is still in the conceptual planning phase.

1.6 Key Issues

From coordination with the City of Littleton and other government agencies, a number of key issues were recognized. These are listed below:

1. Water quality issues should be addressed.

2. Recreation and aesthetic concerns should be addressed.

3. Irrigation ditches will be considered full, thereby accepting no storm runoff.

4. Existing flood control detention facilities should be included in the existing conditions analysis. However, they should not be recognized in the developed conditions analysis unless they are publicly owned and maintained. Non-flood control facilities, such as McLellan Reservoir, should be ignored in the drainage analysis unless an adequate assurances agreement is in place. Inadvertent detention, such as behind railroad embankments, should also be ignored.

5. The City Ditch flows are planned to be piped in a 60 inch conduit with construction being done in three phases.

6. Diversion of storm flows from the Highline Canal into the Jackass Gulch basin needs to be considered.

7. The wetland area on Jackass Gulch at the upstream side of the railroad lines should be protected.

8. Detention facilities should be considered for Jackass Gulch in order to reduce 100-year discharge rates to the capacity of the existing outfall system.

9. Storm flows should not be discharged into McLellan Reservoir except as provided by separate agreement.

10. McLellan Reservoir should be analyzed with and without dedicated flood storage for the Master Plan alternatives.

11. Impacts to the South Platte Park area should be minimized.

1.7 Acknowledgements

This report was prepared by Centennial Engineering, Inc., consulting engineers of Arvada, Colorado, at the request of the Urban Drainage and Flood Control District.

All surveying and topographic data for this study was collected and compiled by Landmark, Ltd., Denver, Colorado, under a separate contract with the Urban Drainage and Flood Control District.

Various agencies, including the City of Littleton, provided information pertaining to the analysis of these basins. Also, coordination was done with J.F. Sato, who is a subconsultant to DeLeuw Cather on the improvements to Santa Fe Drive (see the bibliography for a list of references). Technical data developed in this study is on file with the Urban Drainage and Flood Control District.

SECTION 2
PROJECT HYDROLOGY

2.1 Introduction

The hydrologic analysis was done for the 2-, 5-, 10-, 50-, and 100-year frequencies for both the existing and developed basin conditions.

Each basin was divided into subbasins which had a maximum size of 130 acres and an average size of 100 acres. In delineating subbasins, consideration was given to major drainage features, type of zoning, and land topography.

Imperviousness was determined with the aid of the Littleton zoning map and zoning regulations. The Urban Drainage and Flood Control Design Criteria and the City of Littleton Storm Drainage & Technical Criteria were used as a basis for all hydrologic analysis.

2.2 Design Rainfall

The 1-hour rainfall depths for the 2-, 5-, 10-, 50-, and 100-year events were determined from the Littleton Drainage Criteria and are shown in Table 2-1.

TABLE 2-1
1-Hour Rainfall Depths

FREQUENCY	RAINFALL Inches
2-yr	0.97
5-yr	1.38
10-yr	1.65
50-yr	2.32
100-yr	2.67

2.3 Computer Modeling

Runoff hydrographs were developed for each subbasin using the Colorado Urban Hydrograph Procedure (CUHP) and were then routed using the Environmental Protection Agency Storm Water Management Model (UDSWM2PC). Figure 2-1 shows the CUHP and SWMM networks and Figure 2-2 shows the projected future imperviousness.

2.3.1 CUHP Analysis

Subbasin areas, lengths, centroids, and slopes were determined from 1"=200' topographic mapping with a 2 foot contour interval. Time of concentration and percent imperviousness were determined for the existing and developed conditions of each subbasin. Detention storage depths were taken as the same for all basins, 0.35 inches and 0.05 inches for pervious and impervious areas, respectively. Infiltration rates, which are based on soil type, varied depending on location. However, most soils in the area belong to hydrologic soil group C with initial and final infiltration rates of 3.0 in/hr and 0.50 in/hr., respectively. An infiltration decay coefficient of 0.0018 was used for all soils. The CUHP parameters are listed in Table 2-2.

For basins under 90 acres, a modified time to peak was used instead of the normal procedure for time to peaks. Since all basins were under 160 acres, an estimated peak flow was calculated using the Rational Method. The only basins not analyzed by the CUHP method were those upstream of McLellan Reservoir. The hydrographs from these basins were determined from previous studies.

2.3.2 SWMM Analysis

Two storm routing networks were developed for each of the three major basins and also for the direct flow areas. One network was prepared for existing conditions and one for developed conditions. The existing conditions network recognized all existing detention facilities. This excludes detention in Rangeview Park, Turtle Lake, and McLellan Reservoir since these facilities are not currently used for flood control. Also, no detention was assumed behind railroad embankments or in the irrigation ponds along Rangeview Gulch. The developed conditions network was the same as the existing except fully developed runoff conditions were used and only publicly owned detention facilities were recognized. The only detention facility in the study area which is publicly owned is on Jackass Gulch at Mineral Avenue upstream of the AT&SF Railroad spurline embankment. Table 2-3 summarizes the SWMM network parameters. The peak flows based on developed conditions were used in creating the flood discharge profiles.

For the alternative analysis, the networks were modified, as necessary, to reflect proposed detention facilities, storm sewer improvements, and flow diversions. These new networks were then run with developed runoff flows.

2.4 Hydrology Results

The hydrologic analysis was reviewed by Urban Drainage and approved in a letter dated November 28, 1989.

The results of the hydrologic analysis are summarized in the flood discharge profiles for the 2-, 10- and 100-year events and are shown in Figures 2-3, 2-4 and 2-5. These profiles represent the fully developed basin conditions with public detention facilities recognized. Tables 2-4a and 2-4b list the peak storm discharges and the existing proposed conditions, respectively.

LEGEND

- BASIN BOUNDARY
- (125) SUBBASIN BOUNDARY & I.D.
- [145] SWMM ROUTING ELEMENT & I.D.
- (82) SWMM DIRECT FLOW/DESIGN PT.
- EXISTING FLOOD STORAGE FACILITY

Columbine Valley Country Club

RANGEVIEW GULCH

LITTLETON

SCALE 1" = 1000'

BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC	DESIGNED ____ DATE ____ DRAWN ____ DATE ____ CHECKED ____ DATE ____ REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	RANGEVIEW BASIN CUHP AND SWMM NETWORK	FIGURE 2-1a CEI JN 906.00

JACKASS GULCH

LOWER DAD CLARK GULCH

UPPER DAD CLARK GULCH

SOUTH PARK

SCALE 1" = 1000'

BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC DESIGNED ____ DATE ____ DRAWN ____ DATE ____ CHECKED ____ DATE ____ REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	JACKASS & LOWER DAD CLARK BASINS CUHP AND SWMM NETWORK	FIGURE 2-1b CEI JN 906.00

LEGEND

SYMBOL	PROBABLE FUTURE LAND USE	% IMPERV.
	OPEN SPACE AND AGRICULTURAL	2-10%
	RESIDENTIAL, LIGHT	20-35%
	RESIDENTIAL, NORMAL	40-50%
	RESIDENTIAL, DENSE	60-75%
	COMMERCIAL AND INDUSTRIAL AND PAVED AREAS	75-95%

Columbine Valley
Country Club
Clement Park
Euclid Jr High Sch
Broadmoor Plaza
LITTLETON
MATCH LINE
SCALE 1" = 1000'

BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC	DESIGNED ____ DATE ____ DRAWN ____ DATE ____ CHECKED ____ DATE ____ REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	RANGEVIEW BASIN PROJECTED FUTURE BASIN IMPERVIOUSNESS	FIGURE 2-2a CEI JN 906.00

MATCH LINE

MINERAL AVE

ARAPAHOE CO
DOUGLAS CO

SCALE
1" = 1000'

BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC	DESIGNED ____ DATE ____ DRAWN ____ DATE ____ CHECKED ____ DATE ____ REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	JACKASS & LOWER DAD CLARK BASINS PROJECTED FUTURE BASIN IMPERVIOUSNESS	FIGURE 2-2b CEI JN 906.00

TABLE 2-2 CUHP PARAMETERS

SUB BASIN I.D.	TRIBUTARY AREA (ac)	TRIBUTARY AREA (mi^2)	BASIN LENGTH (mi)	CENTROID LENGTH (mi)	BASIN SLOPE (ft/ft)	TIME OF CONCENTRATION EXISTING (min)	TIME OF CONCENTRATION DEVELOPED (min)	PERCENT IMPERVIOUSNESS EXISTING (%)	PERCENT IMPERVIOUSNESS DEVELOPED (%)	DEPRESSION STORAGE AND INFILTRATION RATE (See Note)
010	44	.0688	.5530	.2936	.0094	50	26	3	4	(1)
015	51	.0797	.4564	.2576	.0162	22	22	49	51	(1)
020	48	.0750	.3977	.1326	.0493	49	23	5	7	(1)
025	98	.1531	.8902	.5208	.0118	93	31	6	64	(1)
030	64	.1067	.3788	.2178	.0227	50	16	8	48	(1)
040	48	.0750	.4830	.2652	.0097	45	24	6	76	(1)
050	56	.0875	.5966	.3693	.0063	99	28	2	42	(1)
060	27	.0422	.4072	.1799	.0074	58	22	2	18	(1)
105	90	.1406	.5114	.2462	.0274	25	25	9	9	(1)
110	84	.1313	.5019	.1894	.0328	25	25	14	14	(1)
115	35	.0547	.5777	.2462	.0294	27	25	27	27	(1)
120	31	.0484	.3314	.1610	.0355	18	18	43	43	(2)
125	57	.0891	.5208	.1989	.0189	24	24	43	43	(3)
130	45	.0703	.5587	.2178	.0180	26	26	28	28	(1)
133	10	.0156	.3977	.2178	.0070	29	22	4	25	(4)
135	24	.0375	.3600	.1420	.0232	26	20	20	39	(3)
140	28	.0438	.3220	.1705	.0267	19	19	46	46	(2)
145	28	.0438	.2652	.1326	.0210	21	18	24	77	(2)
203	53	.0833	.4450	.2180	.0212	17	17	64	87	(1)
205	83	.1297	.6250	.3880	.0076	28	28	41	80	(1)
210	52	.0808	.6250	.2936	.0053	32	28	23	83	(1)
215	45	.0703	.5019	.2936	.0113	25	25	95	95	(1)
220	16	.0250	.2652	.0947	.0164	17	17	50	50	(1)

TABLE 2-2
CUHP PARAMETERS
(Continued)

SUB BASIN I.D.	TRIBUTARY AREA (ac)	TRIBUTARY AREA (mi^2)	BASIN LENGTH (mi)	CENTROID LENGTH (mi)	BASIN SLOPE (ft/ft)	TIME OF CONCENTRATION EXISTING (min)	TIME OF CONCENTRATION DEVELOPED (min)	PERCENT IMPERVIOUSNESS EXISTING (%)	PERCENT IMPERVIOUSNESS DEVELOPED (%)	DEPRESSION STORAGE AND INFILTRATION RATE (See Note)
225	54	.0844	.3598	.1799	.0179	21	21	43	43	(1)
230	25	.0391	.2746	.0947	.0297	18	18	20	20	(1)
235	11	.0172	.2936	.1515	.0303	19	19	19	23	(1)
240	40	.0625	.5966	.2178	.0286	28	28	56	58	(1)
245	60	.0938	.5492	.2462	.0307	28	26	4	43	(1)
250	17	.0266	.2273	.0947	.0607	17	17	2	54	(1)
255	23	.0359	.3030	.0852	.0450	19	19	22	79	(1)
260	18	.0281	.4072	.2273	.0223	36	21	23	69	(1)
360	42	.0656	.5227	.2273	.0206	25	25	45	45	(1)
365	51	.0797	.6061	.3409	.0326	28	28	64	64	(1)
370	41	.0641	.5303	.2652	.0332	20	20	11	13	(1)
375	34	.0531	.4830	.2557	.0439	38	24	2	80	(1)
380	8	.0125	.3125	.1515	.0150	33	19	21	36	(1)
385	16	.0250	.4545	.2178	.0140	40	23	21	32	(1)
390	98	.1531	.6345	.3598	.0100	55	23	9	66	(1)

NOTE: Depression storage was taken as the same for all basins: Impervious Areas = 0.05 inches
Pervious Areas = 0.35 inches

Infiltration rates were one of four types:

	Initial Rate	Final Rate	Decay Coeff.
(1)	3.0	0.5	0.0018
(2)	3.4	0.52	0.0018
(3)	3.7	0.55	0.0018
(4)	4.5	0.6	0.0018

TABLE 2-3
SWMM NETWORK PARAMETERS
(100-YEAR FREQUENCY)*

CONVEYANCE ELEMENT NUMBER	NEXT D/S CONVEYANCE ELEMENT	TYPE OF CONVEYANCE ELEMENT	LENGTH (ft)	SLOPE (ft/ft)	PIPE DIAMETER (ft)	CHANNEL BOTTOM WIDTH (ft)	CHANNEL SIDE SLOPES LEFT (ft/ft)	CHANNEL SIDE SLOPES RIGHT (ft/ft)	MANNING'S COEFF.	OVERFLOW DEPTH (ft)
DIRECT FLOW AREAS - EXISTING CONDITION										
70	75	Pipe with overflow across R.R.	300	0.025	2.5				0.016	2.5
				0.025		5.0	20	20	0.020	
75	--	Channel to South Platte R.	3750	0.009		3.0	50	50	0.040	
DIRECT FLOW AREAS - DEVELOPED CONDITION										
		(SAME AS EXISTING)								
RANGEVIEW GULCH - EXISTING CONDITION										
110	120	Channel	1300	0.0208		25	10	10	0.060	
120	130	Channel	950	0.0179		10	6	6	0.055	
130	160	Pipe with overflow	1300	0.020	2				0.024	2
				0.020		1	20	20	0.020	
140	160	Flow down Costilla Street	2000	0.015		1	20	20	0.020	
150	160	Flow down Costilla Avenue	800	0.033		1	20	20	0.020	
160	170	Channel	800	0.0233		5	25	25	0.030	
170	175	Overflow across AT&SF R.R.	100	0.020		4	25	25	0.030	
175	180	Channel to west side of Santa Fe	200	0.020		4	25	25	0.030	
180	--	Channel to South Platte R.	1550	0.018		50	20	20	0.030	
RANGEVIEW GULCH - DEVELOPED CONDITION										
		(SAME AS EXISTING)								
JACKASS GULCH - EXISTING CONDITION										
205	91	Pipe with overflow	2000	0.0085	3				0.016	3
				0.0060		4	5	5	0.040	

TABLE 2-3
SWMM NETWORK PARAMETERS
(100-YEAR FREQUENCY)*
(Continued)

CONVEYANCE ELEMENT NUMBER	NEXT D/S CONVEYANCE ELEMENT	TYPE OF CONVEYANCE ELEMENT	LENGTH (ft)	SLOPE (ft/ft)	PIPE DIAMETER (ft)	CHANNEL BOTTOM WIDTH (ft)	CHANNEL SIDE SLOPES LEFT (ft/ft)	CHANNEL SIDE SLOPES RIGHT (ft/ft)	MANNING'S COEFF.	OVERFLOW DEPTH (ft)
91	210	Pipe - detention simulation	1.0	0.0068	4.5	--	--	--	0.016	4.5
210	215	Pipe with overflow	2700	0.008	4.5				0.016	4.5
				0.017		1	20	20	0.020	
215	250	Channel with overflow	1550	0.020		0.5	12	12	0.016	0.5
				0.030		4	4	4	0.040	
220	92	Channel	1800	0.014		1	4	4	0.040	5
92	225	Pipe - detention simulation	1.0	0.0265	3	--	--	--	0.016	3
225	230	Pipe with overflow	1300	0.0285	3				0.016	3
				0.0285		1	20	20	0.020	
230	235	Pipe with overflow	750	0.0125	3.5				0.016	3.5
				0.0125		1	20	20	0.020	
235	250	Channel to Gulch	500	0.030		4	4	4	0.040	
240	93	Pipe - out of sump area	1650	0.0093	4.5				0.016	4.5
93	245	Pipe - detention simulation	300	0.080	2.25				0.016	2.25
245	250	Channel to Gulch	350	0.040		4	4	4	0.040	
250	95	Channel	2500	0.023		4	4	4	0.040	
95	255	Pipe with overflow - detention behind Jackass Hill Road.	150	0.0250	5.5				0.016	4
				0.0250		1	20	20	0.020	
255	96	Channel	500	0.0220		4	4	4	0.040	
96	260	Detention release VOLUME = (For Lower Pond) OUTFLOW =	0 ac-ft 0 cfs	12 ac-ft 170 cfs	15 ac-ft 700 cfs	19 ac-ft 1400 cfs				
260	265	Pipe with overflow	700	0.0190	4				0.016	4

TABLE 2-3
SWMM NETWORK PARAMETERS
(100-YEAR FREQUENCY)*
(Continued)

CONVEYANCE ELEMENT NUMBER	NEXT D/S CONVEYANCE ELEMENT	TYPE OF CONVEYANCE ELEMENT	LENGTH (ft)	SLOPE (ft/ft)	PIPE DIAMETER (ft)	CHANNEL BOTTOM WIDTH (ft)	CHANNEL SIDE SLOPES LEFT (ft/ft)	CHANNEL SIDE SLOPES RIGHT (ft/ft)	MANNING'S COEFF.	OVERFLOW DEPTH (ft)
				0.040		1	20	20	0.020	
265	270	Pipe with overflow	1300	0.015	5				0.016	5
				0.015		1	20	20	0.020	
270	--	Channel	600	0.010		10	4	4	0.040	
JACKASS GULCH - DEVELOPED CONDITION										
		SAME AS EXISTING EXCEPT DELETE 91, 92, 93, AND 95.								
LOWER DAD CLARK GULCH - EXISTING CONDITION										
91	210	Pipe with overflow - detention simulation	1.0	0.0265	1.5				0.016	1.5
				0.0265		1	20	20	0.020	1.95
210	220	Channel	1000	0.028		4	5	5	0.030	
220	92	Pipe with overflow	300	0.020	3				0.016	3
				0.020		10	25	25	0.040	
92	230	Pipe with overflow - detention simulation	1.0	0.0165	3				0.016	3
				0.0165		1	20	20	0.020	3.65
230	250	Channel	1200	0.017		5	10	10	0.040	
301	240	Inflow hydrograph TIME =	1.0 hr	1.3 hr	1.7 hr	2.0 hr	2.3 hr	3.0 hr		
		INFLOW =	0 cfs	324 cfs	800 cfs	1052 cfs	1168 cfs	1260 cfs		
		TIME =	4.0 hr	5.33 hr	8.0 hr	8.67 hr	10.0 hr	12.0 hr		
		INFLOW =	1260 cfs	1080 cfs	360 cfs	230 cfs	90 cfs	60 cfs		
302	240	Inflow hydrograph TIME =	0 hr	1.0 hr	4.13 hr					
		INFLOW =	0 cfs	352 cfs	0 cfs					

TABLE 2-3
SWMM NETWORK PARAMETERS
(100-YEAR FREQUENCY)*
(Continued)

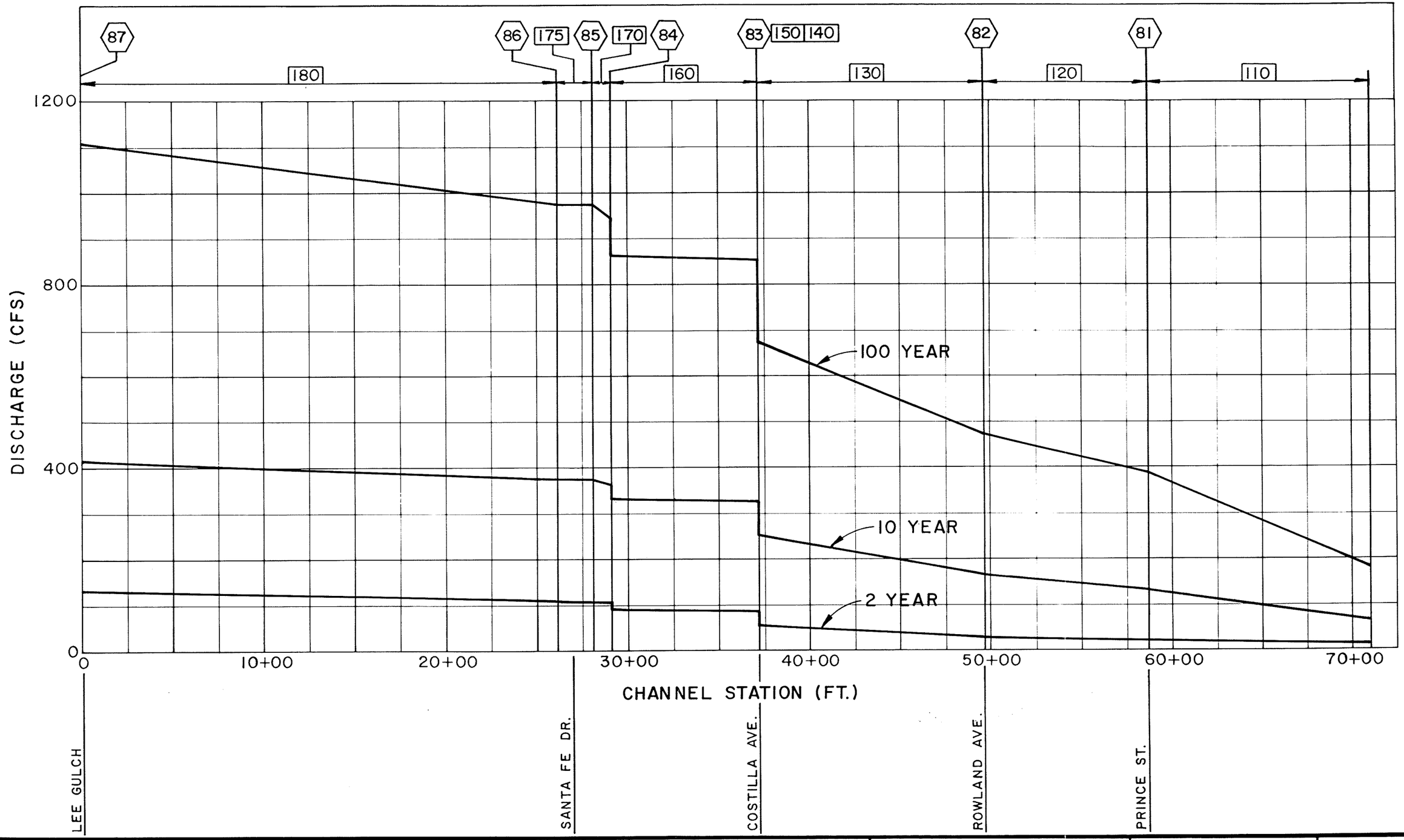
CONVEYANCE ELEMENT NUMBER	NEXT D/S CONVEYANCE ELEMENT	TYPE OF CONVEYANCE ELEMENT	LENGTH (ft)	SLOPE (ft/ft)	PIPE DIAMETER (ft)	CHANNEL BOTTOM WIDTH (ft)	CHANNEL SIDE SLOPES LEFT (ft/ft)	CHANNEL SIDE SLOPES RIGHT (ft/ft)	MANNING'S COEFF.	OVERFLOW DEPTH (ft)
303	240	Inflow hydrograph TIME = INFLOW =	0 hr 0 cfs	0.33 hr 114 cfs	2.0 hr 0 cfs					
240	242	Channel	4200	0.003		10	4	4	.040	
304	242	Inflow hydrograph TIME = INFLOW =	0 hr 0 cfs	1.0 hr 635 cfs	2.0 hr 0 cfs					
305	242	Inflow hydrograph TIME = INFLOW =	0 hr 0 cfs	0.83 hr 315 cfs	1.98 hr 0 cfs					
306	242	Inflow hydrograph TIME = INFLOW=	0 hr 0 cfs	1.0 hr 285 cfs	2.2 hr 0 cfs					
242	245	Channel	4200	0.003		10	4	4	0.040	
307	245	Inflow hydrograph TIME = INFLOW =	0 hr 0 cfs	0.62 hr 62 cfs	1.62 hr 0 cfs					
308	245	Inflow hydrograph TIME = INFLOW =	0 hr 0 cfs	0.38 hr 30.2 cfs	1.37 hr 0 cfs					
245	250	Channel	2200	0.010		20	5	5	0.040	
250	260	Channel	250	0.010		50	3	3	0.040	
260	270	Channel with overflow	2400	0.005		3	3	3	0.040	2
				0.005		15	20	20	0.070	
270	--	Channel to South Platte R.	1100	0.008		3	50	50	0.070	
LOWER DAD CLARK GULCH - DEVELOPED CONDITION										
260	270	SAME AS EXISTING EXCEPT DELETE 91 & 92 AND REPLACE 260 WITH THE FOLLOWING: Channel	2400	0.005		20	4	4	.040	
LOWER DAD CLARK GULCH - DEVELOPED CONDITION Assuming McLellan Reservoir has adequate assurances agreement										

TABLE 2-3
SWMM NETWORK PARAMETERS
(100-YEAR FREQUENCY)*
(Continued)

CONVEYANCE ELEMENT NUMBER	NEXT D/S CONVEYANCE ELEMENT	TYPE OF CONVEYANCE ELEMENT	LENGTH (ft)	SLOPE (ft/ft)	PIPE DIAMETER (ft)	CHANNEL BOTTOM WIDTH (ft)	CHANNEL SIDE SLOPES LEFT (ft/ft)	CHANNEL SIDE SLOPES RIGHT (ft/ft)	MANNING'S COEFF.	OVERFLOW DEPTH (ft)
		SAME AS DEVELOPED CONDITION ABOVE EXCEPT ALL INFLOW HYDROGRAPHS PLUS ELEMENTS 240 & 242 ARE REPLACED WITH THE FOLLOWING:								
311	73		0 hr	0.67 hr	1.0 hr	1.17 hr	1.67 hr	2.0 hr		
		Inflow hydrograph TIME =	0 cfs	1300 cfs	1686 cfs	1530 cfs	1530 cfs	1340 cfs		
		INFLOW =								
			3.67 hr	5.33 hr	8.0 hr	8.67 hr	10.0 hr	12.0 hr		
		TIME =	1340 cfs	1080 cfs	360 cfs	230 cfs	90 cfs	60 cfs		
		INFLOW =								
73	245		0	100 ac-ft	200 ac-ft	325 ac-ft	450 ac-ft	550 ac-ft	650 ac-ft	
		Detention release VOLUME =	0	200 cfs	400 cfs	720 cfs	1100 cfs	1490 cfs	2000 cfs	
		OUTFLOW =								

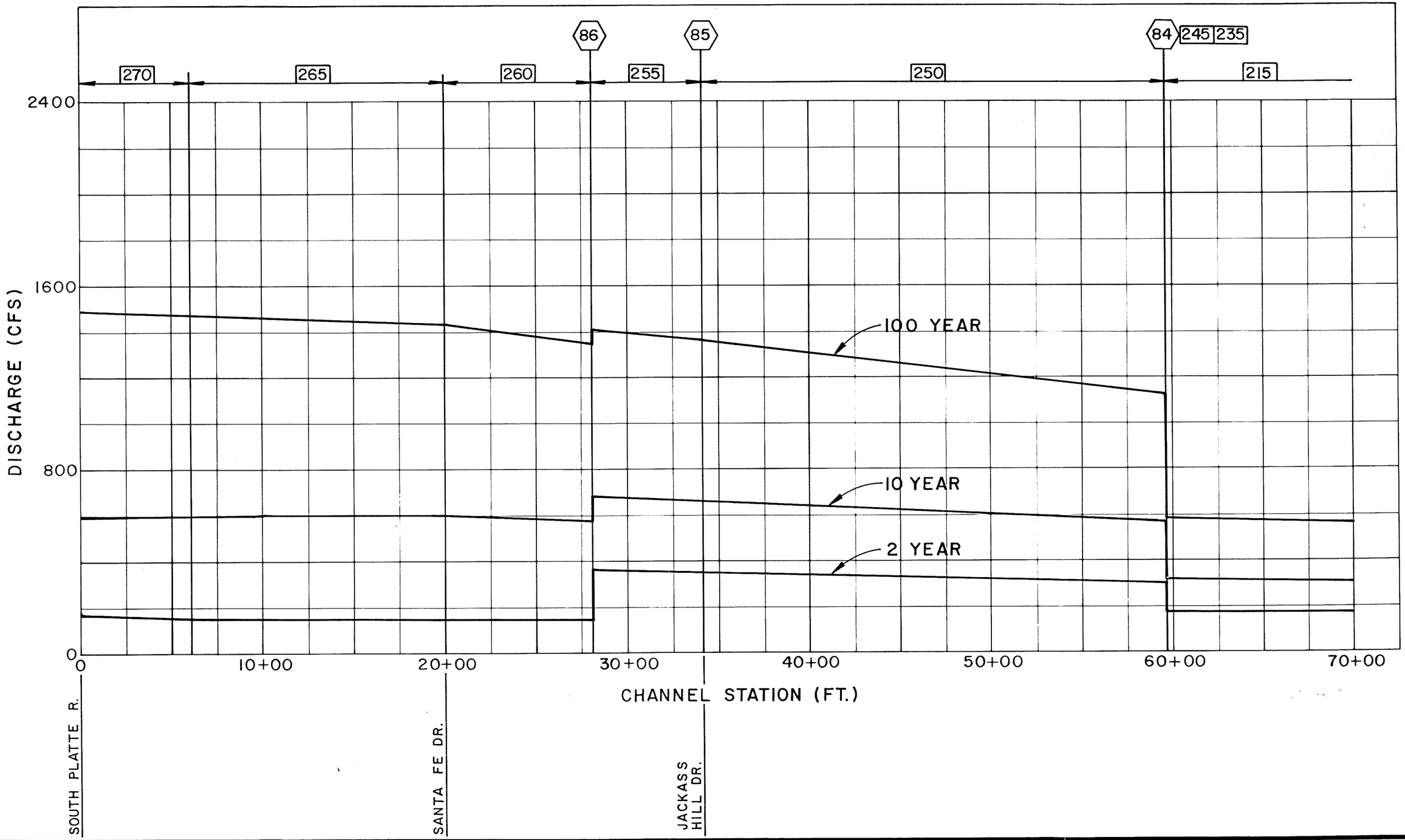
* NOTE: These parameters are for the 100-year frequency storm. For the other frequencies the only thing that will change is the discharges in the inflow hydrographs which are a percentage of the 100-year: 50-year = 80%, 10-yr = 50%, 5-yr = 40%, 2-yr = 20%.

RANGEVIEW GULCH
DEVELOPED CONDITION



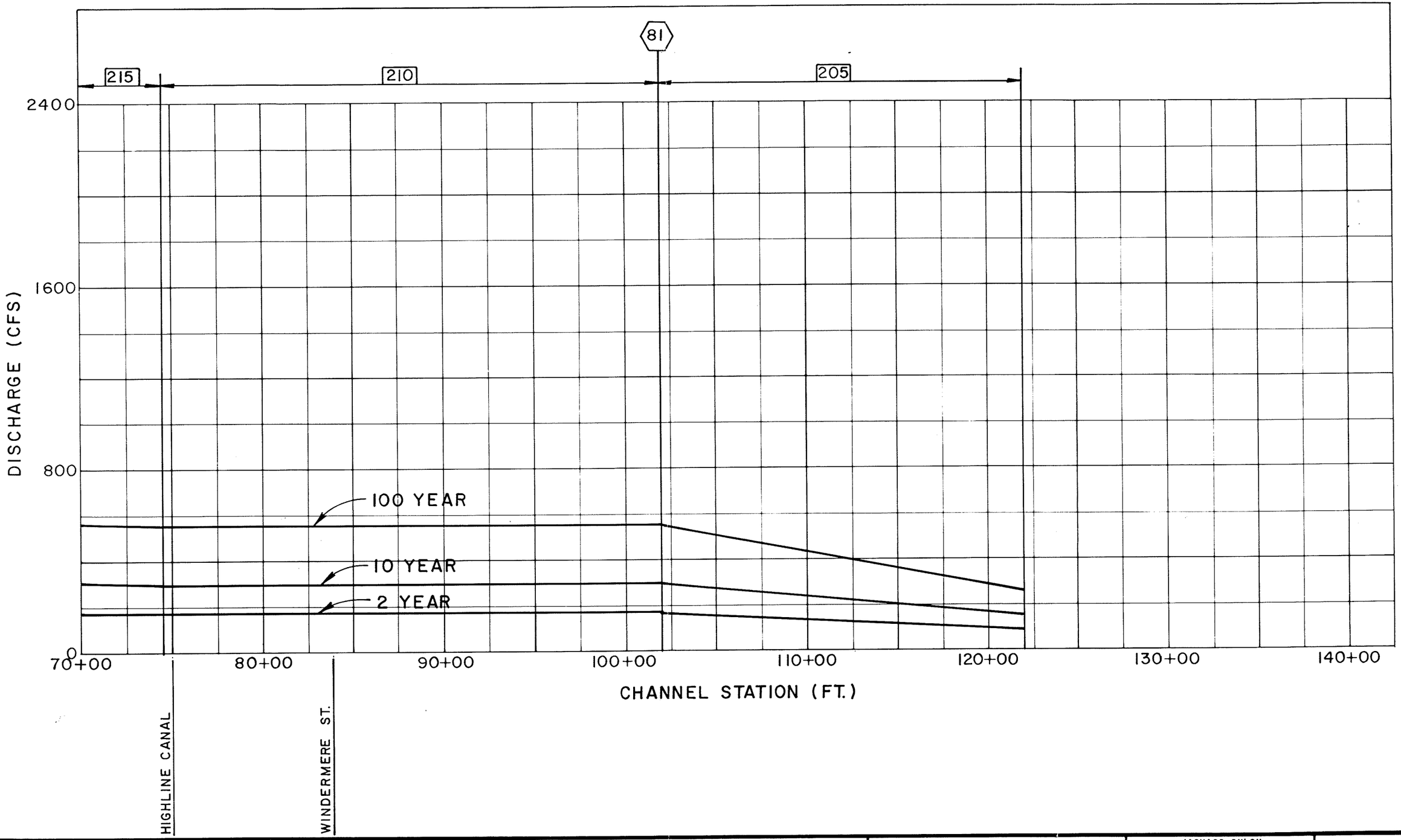
	CENTENNIAL ENGINEERING INC DESIGNED ____ DATE ____ DRAWN ____ DATE ____ CHECKED ____ DATE ____ REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	RANGEVIEW GULCH DISCHARGE PROFILE DEVELOPED CONDITION	FIGURE 2-3 CEI JN 906.00

JACKASS GULCH
DEVELOPED CONDITION



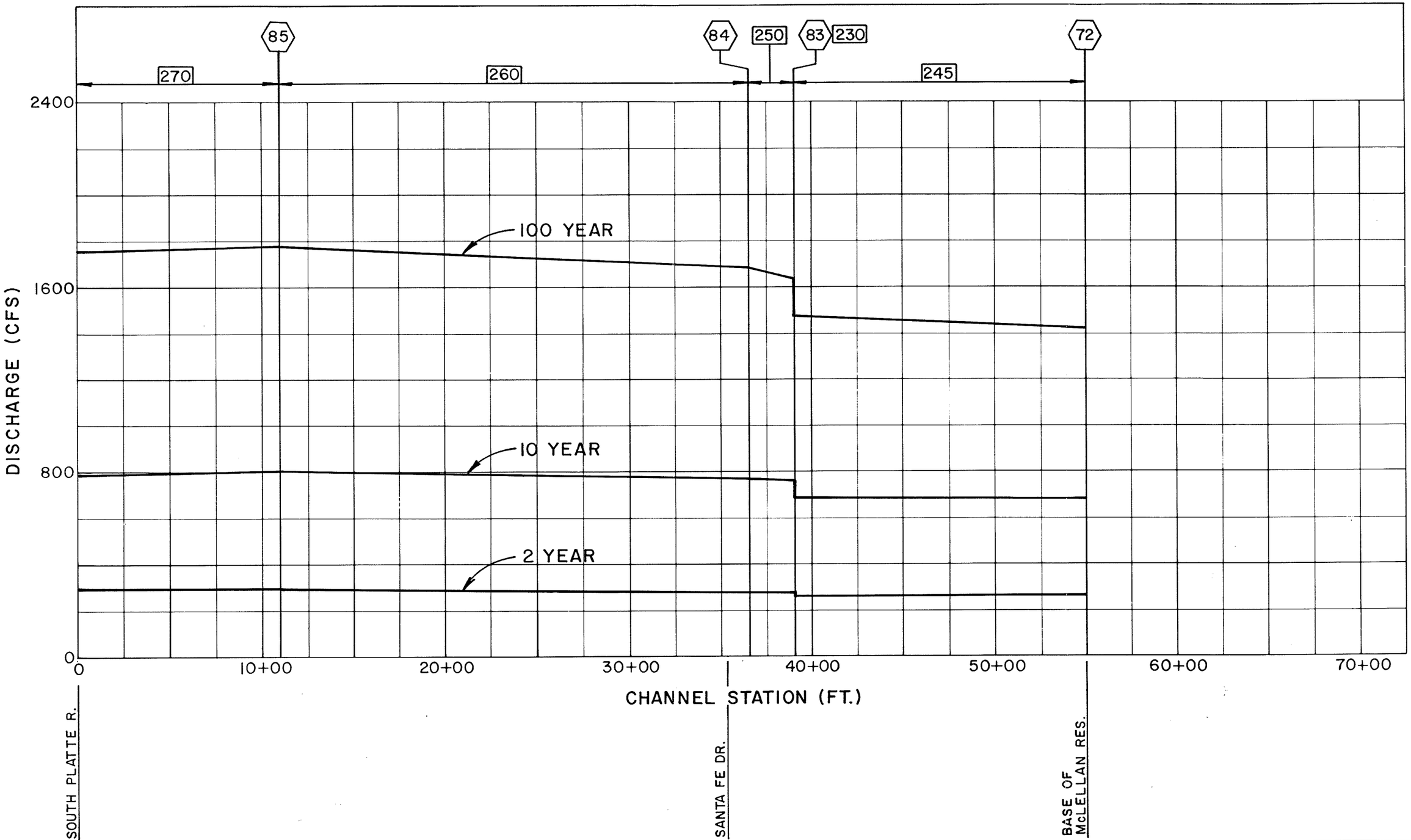
	CENTENNIAL ENGINEERING INC DESIGNED ____ DATE ____ DRAWN ____ DATE ____ CHECKED ____ DATE ____ REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	JACKASS GULCH STA. 0+00 TO STA. 70+00 DISCHARGE PROFILE DEVELOPED CONDITION	FIGURE 2-4a CEI JN 906.00

JACKASS GULCH
DEVELOPED CONDITION



	CENTENNIAL ENGINEERING INC DESIGNED ____ DATE ____ DRAWN ____ DATE ____ CHECKED ____ DATE ____ REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	JACKASS GULCH STA. 70+00 TO STA. 122+00 DISCHARGE PROFILE DEVELOPED CONDITION	FIGURE 2–4b CEI JN 906.00

LOWER DAD CLARK GULCH
DEVELOPED CONDITION



	CENTENNIAL ENGINEERING INC DESIGNED ____ DATE ____ DRAWN ____ DATE ____ CHECKED ____ DATE ____ REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	LOWER DAD CLARK GULCH DISCHARGE PROFILE DEVELOPED CONDITION	FIGURE 2–5 CEI JN 906.00

TABLE 2-4a
PEAK DISCHARGES - EXISTING CONDITION

SUB BASIN I.D.	TRIBUTARY AREA (acres)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)
010	44	2	15	24	54	70
015	51	38	68	90	154	185
020	48	3	18	27	60	77
025	98	4	24	36	81	104
030	68	5	28	41	89	113
040	48	3	20	29	64	82
050	56	1	11	18	42	55
060	27	1	8	12	27	35
105	90	10	46	67	144	183
110	84	17	69	100	199	252
115	35	12	29	40	76	94
120	31	22	41	55	97	119
125	57	35	64	83	152	184
130	45	16	40	55	104	128
133	10	1	3	5	13	18
135	24	6	16	24	48	61
140	28	20	38	50	87	105
145	28	10	26	36	69	87
203	53	62	102	128	206	246
205	83	45	91	118	210	258
210	52	14	39	53	104	130
215	45	70	100	119	173	199
220	16	13	24	31	53	64
225	54	36	70	93	164	198
230	25	8	26	36	68	86

TABLE 2-4a
PEAK DISCHARGES - EXISTING CONDITION
(Continued)

SUB BASIN I.D.	TRIBUTARY AREA (acres)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)
235	11	3	10	14	26	33
240	40	31	53	66	110	133
245	60	4	36	54	119	152
250	17	1.0	13	19	41	53
255	23	7	23	32	60	76
260	18	4	11	14	29	36
360	42	25	49	62	108	133
365	51	46	75	93	151	181
370	41	7	34	50	100	128
375	34	1.0	15	22	50	65
380	8	2	4	6	12	15
385	16	3	8	11	23	28
390	98	7	33	48	106	135

TABLE 2-4b
PEAK DISCHARGES -DEVELOPED CONDITIONS

SUB BASIN I.D.	TRIBUTARY AREA (acres)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)
010	44	3	27	40	88	112
015	51	40	70	92	157	187
020	48	6	34	51	106	136
025	98	93	154	190	307	369
030	68	58	111	144	243	296
040	48	57	87	107	166	194
050	56	30	61	78	139	170
060	27	7	23	33	63	80
105	90	10	46	67	144	183
110	84	17	69	100	199	252
115	35	12	31	43	81	100
120	31	22	41	55	97	119
125	57	35	64	83	152	184
130	45	16	40	55	104	128
133	10	3	7	10	20	25
135	24	14	27	36	66	81
140	28	20	38	50	87	105
145	28	39	59	73	112	132
203	53	87	128	153	225	266
205	83	103	155	186	284	338
210	52	65	96	115	174	207
215	45	70	100	119	173	199
220	16	15	29	36	60	74
225	54	36	70	93	164	198
230	25	8	26	36	68	86

TABLE - 2-4b
PEAK DISCHARGES - DEVELOPED CONDITIONS
(Continued)

SUB BASIN I.D.	TRIBUTARY AREA (acres)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)
235	11	3	10	14	27	33
240	40	31	53	66	110	133
245	60	34	68	87	154	189
250	17	15	27	35	58	70
255	23	32	49	60	91	107
260	18	20	31	38	61	72
360	42	25	49	62	108	133
365	51	46	75	93	151	181
370	41	8	36	52	103	131
375	34	42	63	77	118	137
380	8	4	8	11	20	25
385	16	6	15	20	36	45
390	98	114	182	230	369	433

SECTION 3
ALTERNATIVE DEVELOPMENT AND EVALUATION

3.1 Introduction

There are three basins under consideration, Rangeview, Jackass, and Lower Dad Clark. The direct flow areas, which cover about 440 acres of land, were not analyzed since these areas will discharge directly into the South Platte River through onsite drainage systems as development progresses. Storm discharges developed in Direct Flow Basin 020 (east of the railroad lines) should be restricted to historic rates and released through the existing culverts under the railways and Santa Fe Drive.

Three outfall alternatives were developed and evaluated for each basin. As described earlier, additional hydrologic routing was done, if necessary. An estimated construction cost was projected for each of the three alternatives and an evaluation matrix was developed. The drainage basins are independent of each other, and therefore, different alternatives can be selected for each.

3.2 Design Criteria

Unless specific criteria was stipulated by the Project Sponsors, the Urban Storm Drainage Criteria Manual (USDCM) and the City of Littleton Drainage Criteria Manual were used as a basis of the design.

3.2.1. Basis for Outfall Service to 100 Acre Basins.

Outfall systems were developed to serve all basins of approximately 100 acres or more in area. This area criterion is a "rule of thumb" and is based on the observation that, during a 100-year runoff event, a typical urban watershed with a two-year storm sewer capacity will generally convey the flow in a combination of pipe and street drainage systems for tributary areas of 100 acres or smaller.

In watersheds larger than 100 acres, the local storm sewer collection system and allowable street capacity become inadequate to handle major runoff events, and a major outfall system becomes necessary. Because Littleton requires a two-year storm sewer capacity for new developments, a basin size of 100 acres was selected as the smallest area to which an outfall system would extend.

3.2.2 Open Channels

Open channels were designed specifically for district maintenance eligibility. All open channels were designed as trapezoidal sections with side slopes of 4:1 and flow depths less than or equal to 5 feet.

Channel slopes generally ranged from 0.2 to 0.4 percent except where it was desired to minimize the number of drop structures. The Froude Number was limited to 0.8 and velocities were limited to 7 fps (5 fps in sandy soils).

Most channels were designed to be grass-lined with an assumed n-value of 0.035; channels with wetland bottoms were assigned n-values of 0.045 for a major storm event and 0.07 for low flows.

Three foot vertical concrete wall drop structures were used for grade control, and trickle channels were proposed for all grass-lined channels. Maintenance roads were also proposed for all channels except in areas where access exists from adjacent roads.

3.2.3 Crossing Structures

Two types of crossing structures were used for this study: culverts and bridges. The only existing bridge structures along the project reaches are located on Lower Dad Clark Gulch for the railroad and highway crossings. Since these structures are adequate for the flow, no improvements were proposed except as required for highway improvements. Culvert crossings were designed for both inlet and outlet control conditions and for a maximum HW/D of 1.5. Where outlet velocities exceed 12 fps an energy dissipator will be recommended. The only existing crossing designed specifically for overtopping is located at Jackass Hill Road. (The development plan utilizes the area behind the roadway as a private detention facility.)

3.2.4 Detention Facilities

Detention facilities were designed to be non-jurisdictional facilities, which means, the facility is not under the State Engineer's control. There are three basic requirements for non-jurisdictional facilities as specified in the State of Colorado "Rules and Regulations for Dam Safety and Dam Construction":

1. The distance from the elevation of the original thalweg at the center of the embankment to the elevation of the emergency spillway flowline must be 10 feet or less.

2. And the available storage is limited to a maximum of 100 ac-ft. as measured at the emergency spillway flowline.

3. And the maximum water surface area is limited to 20 acres as measured at the emergency spillway flowline.

Roadway or railroad embankments which are normally dry and which are not designed or operated for the purpose of impounding water are considered exempt even if they do not meet any of the above listed requirements for non-jurisdictional structures.

All detention facilities must be designed for both the 10-year and 100-year storm frequencies as per Littleton drainage criteria. The public detention facilities must have a minimum freeboard of 3 feet to meet FEMA criteria. Like open channels, detention facilities were also designed for district maintenance eligibility. Side slopes on the embankment were limited to 3:1 and side slopes for the rest of the pond were limited to 4:1. Detention facilities were one of three types: 1. ponds with a permanent water surface, 2. wetland bottom facilities, and 3. normally-dry facilities. The normally-dry detention ponds were designed with a minimum cross slope of 2% and with a concrete trickle channel at a minimum slope of 1%. Maintenance access was required for all detention facilities.

3.2.5 Water Quality Facilities

Water quality and sedimentation ponds are required for all new developments that are tributary to the South Platte River Park. The entire study area is within the designated impact area. The planning of these facilities is the responsibility of each individual developer and was not considered in the cost evaluations except for Lower Dad Clark Gulch. On Dad Clark, the most practical design would be for the Santa Fe Park development to drain directly into Dad Clark Gulch and to construct a water quality pond on the gulch just upstream of the South Platte Park. This design was included in the cost evaluation for each of the three alternatives

3.2.6 Storm Sewer Facilities

All storm sewers were designed using the Manning's equation under full flowing conditions. Reinforced concrete pipe (RCP) was used for all storm sewer design, assuming an $n=0.013$. Outlet velocities in excess of 12 fps will require energy dissipation.

3.2.7 Irrigation Facilities

There are three irrigation facilities which are considered in the alternative analysis. The first is the flume structure for the City Ditch across Dad Clark Gulch. This is assumed to remain in service and has no effect on the alternative evaluation process. The second facility is the Highline Canal crossing through the Jackass Gulch basin. The possibility of storm flows being discharged into Jackass Gulch was an option of the alternative development. The third facility

is the City Ditch around Turtle Lake in the Rangeview basin. This will be relocated in a 60" RCP in the Turtle Lake dam embankment. (Englewood plans to relocate the ditch into a 60" pipe in three phases). The discharge of storm flows to any of the irrigation facilities was not considered in this study.

3.3 Unit Cost Evaluation

The unit costs used for the alternative evaluation have been separated into three categories: grass-lined channel costs, detention storage costs, and storm sewer costs. These costs are shown in Tables 3-1, 3-2 and 3-3, respectively.

Unit costs for construction, property acquisition, and maintenance are listed in these tables. Engineering, legal and administrative, and utility relocation costs are added to each alternative as a percent contingency. All appurtenances of a specific item were included in the unit cost for that item. Some examples are riprap for drop structures, headwall and wingwalls for culverts, and manholes and inlets for storm sewer systems. Riprap for channel areas other than around drop structures was kept as a separate item.

TABLE 3-1

GRASS-LINED CHANNEL UNIT COSTS

Item Description	Unit	Cost
CAPITAL COSTS:		
EARTHWORK:		
Excavation	Cubic Yard	$5.00
Embankment	Cubic Yard	4.00
SITE PREPARATION AND RESTORATION:		
Clearing and Stripping	Acre	3,000.00
Restoration (top soil, grading, and revegetation)	Acre	2,500.00
Wetlands Restoration		
General Channel Areas	Acre	5,000.00
South Platte Park Area	Acre	25,000.00
Maintenance Road	Linear Foot	25.00
HYDRAULIC STRUCTURES:		
Trickle Channel	Linear Foot	20.00
Riprap and Bedding	Cubic Yard	50.00
Concrete Drop Structure - 3 feet (excavation, concrete wall, footing, backfill & riprap)	Linear Foot	225.00
Low Water Crossing Structure (excavation, concrete, riprap and backfill)	Each	5,000.00

(Table 3-1 continued)

Reinforced Concrete Culvert
(excavation, bedding, backfill, headwall, and wingwalls)

Span (feet)	x	Rise (Feet)		
4	x	4	Linear Foot	$200.00
6	x	4	Linear Foot	250.00
6	x	6	Linear Foot	290.00
7	x	4	Linear Foot	300.00
8	x	6	Linear Foot	430.00
8	x	8	Linear Foot	470.00
10	x	6	Linear Foot	600.00
10	x	8	Linear Foot	660.00
10	x	10	Linear Foot	720.00
12	x	8	Linear Foot	780.00
12	x	10	Linear Foot	840.00
12	x	12	Linear Foot	900.00

ENGINEERING, LEGAL AND ADMINISTRATIVE, UTILITY RELOCATION:		35%
CONTINGENCY:		15%

LAND VALUE COSTS:

Floodway Property	Acre	$4,500.00
Residential Property	Acre	40,000.00
Industrial Property	Acre	85,000.00
Retail Commercial Property	Acre	130,000.00

ANNUAL ROUTINE MAINTENANCE COSTS:

Mowing (3 times/year)	Acre	$1,000.00
Debris and Trash Removal (3 times/year)	Acre	250.00

TABLE 3-2

DETENTION STORAGE UNIT COSTS

Item Description	Unit	Cost
CAPITAL COSTS:		
EARTHWORK:		
Excavation	Cubic Yard	$5.00
Embankment	Cubic Yard	4.00
SITE PREPARATION AND RESTORATION:		
Clearing and Stripping	Acre	3000.00
Restoration (top soil, grading, and revegetation)	Acre	2500.00
Wetlands Restoration	Acre	5000.00
HYDRAULIC STRUCTURES:		
Trickle Channel	Linear Foot	20.00
Riprap & Bedding	Cubic Yard	50.00
Concrete Drop Structure - 3 feet (excavation, concrete wall footing, backfill, & riprap)	Linear Foot	225.00
Outlet Works (concrete outlet structure, trash rack, outlet pipe, energy dissipator, and emergency spillway)	Each	30,000.00 to 45,000.00
Highline Canal Overflow Spillway (excavation, concrete, riprap, & backfill)	Each	30,000.00

(Table 3-2 continued)

ENGINEERING, LEGAL AND ADMINISTRATIVE, UTILITY RELOCATION:	35%
CONTINGENCY:	15%

LAND VALUE COSTS:

Residential Property	Acre	$40,000.00
Industrial Property	Acre	85,000.00
Retail Commercial Property	Acre	130,000.00

ANNUAL ROUTINE MAINTENANCE COSTS:

Mowing (3 times/year)	Acre	$1,000.00
Debris and Trash Removal (3 times/year)	Acre	250.00
Detention Area Sediment Removal (once/year)	Lump Sum	1,000.00

TABLE 3-3

STORM SEWER UNIT COSTS

Item Description	Unit	Cost
CAPITAL COSTS:		
Reinforced Concrete Pipe: (excavation, bedding, backfill, manholes and inlets)		
18 inch	Linear Foot	$50.00
24 inch	Linear Foot	60.00
30 inch	Linear Foot	75.00
36 inch	Linear Foot	90.00
42 inch	Linear Foot	110.00
48 inch	Linear Foot	130.00
54 inch	Linear Foot	150.00
60 inch	Linear Foot	175.00
66 inch	Linear Foot	190.00
72 inch	Linear Foot	210.00
78 inch	Linear Foot	250.00
Jacking Cost	Linear Foot	4 times basic pipe cost
ENGINEERING, LEGAL AND ADMINISTRATIVE, UTILITY RELOCATION:		35%
CONTINGENCY:		15%
ANNUAL ROUTINE MAINTENANCE COSTS:		
Cleaning and Debris Removal (once a year)	Linear Foot	$0.30

3.4 Study Reaches

Each of the three major basins were divided into two or three study reaches. These reaches are used to help define the alternatives and are described below.

RANGEVIEW GULCH

Reach 1.1 - From the South Platte River to the east side of the railroad lines.

Reach 1.2 - From the railroad lines to the upper basin limit at the Highline Canal.

JACKASS GULCH

Reach 2.1 - From the South Platte River to the east side of the railroad lines at the existing regional detention pond.

Reach 2.2 - From the regional detention pond to Highline Canal.

Reach 2.3 - Upstream of Highline Canal to Broadway.

LOWER DAD CLARK GULCH

Reach 3.1 - From the South Platte River to the east side of the railroad lines.

Reach 3.2 - Upstream of the railroad lines to McLellan Reservoir

3.5 Drainage Problems and Maintenance Needs

In developing the alternatives, consideration was given to known flood prone areas and maintenance needs. There are two areas on Rangeview Gulch which are flood prone: 1. The residential area just upstream of Turtle Lake, which does not have an adequate drainage system to convey storm flows, and 2. the area downstream of Santa Fe Drive which has no defined channel. Turtle Lake is currently only accessible by the irrigation path coming from the north along the City Ditch.

Flooding will occur on Jackass Gulch downstream of the lower detention pond due to the inadequate outfall system. Water will pond at Mineral Avenue and Santa Fe Drive and will then flood to the areas north and south of Mineral Avenue as it flows to the South Platte River. Currently, there are only a few areas which are accessible for maintenance.

Lower Dad Clark Gulch has no major flood problems and most of the channel is accessible for maintenance if the proper right-of-way is obtained.

3.6 Alternative Descriptions

Three alternatives were developed for each major basin. (See Figures 3-1 and 3-2.) The main difference between alternatives is the amount of detention and the size of outfall facilities. The alignment and type of proposed facilities are generally the same for all alternatives. The various alternative components were sized to convey up to and including the 100-year event, unless stated otherwise for a specific component.

3.6.1 Rangeview Gulch

The alternative development for Rangeview Gulch has three variables: 1. the possibility of detention facilities at Rangeview Park and Turtle Lake, 2. the construction of a lateral storm sewer system from Turtle Lake to South Costilla Street, and, 3. a proposed outfall from Turtle Lake which goes north along the east side of the railroad, combines with flows from the subbasin north of Turtle Lake, and then discharges through a new culvert crossing under the railroads and Santa Fe Drive.

ALTERNATIVE 1

Reach 1.1 - Open channel from the old South Platte River Channel near Lee Gulch to the existing culvert crossing under Santa Fe Drive, low water crossing structure for a future river access road, culvert improvements under railroad lines and highway just below Turtle Lake, new culvert crossing under railroad lines and highway for subbasin north of Turtle Lake.

Reach 1.2 - Embankment, outlet, and spillway improvements to direct Turtle Lake discharges west to railroad culverts, relocation of City Ditch in 60" pipe under dam embankment, storm sewer improvements between Turtle Lake and Rangeview Park (assumes flow in swale just upstream of the lake and flow in Curtice Street contained within existing 50 foot ROW), inlet improvements at Ridgeview Park, culvert improvements at Prince Street.

ALTERNATIVE 2

Reach 1.1 - Same as proposed in Alternative 1
Reach 1.2 - Same as Alternative 1 but with the following additions: Detention at Turtle Lake with a permanent pool, lateral storm sewer system from Turtle Lake to South Costilla Street.

ALTERNATIVE 3

Reach 1.1 - Same as Alternative 1 but with the following exception: Existing culvert crossing under railroad lines and highway will not be used, new culvert crossing will be constructed north of Turtle Lake for Turtle Lake flows and flows from north subbasin.

Reach 1.2 - Same as Alternative 1 but with the following modification: Outfall from Turtle Lake will extend north to new culvert crossing, detention at Rangeview Park with permanent pool.

3.6.2 Jackass Gulch

There are three major factors which distinguish the various alternatives:
1. the construction of an additional outfall system to the South Platte River,
2. the acquisition of existing detention ponds on private developments, and
3. the addition of storm flows from Highline Canal.

ALTERNATIVE 1

Reach 2.1 - New outfall to Dad Clark Gulch along east side of railroad lines with the option of going northwest to the South Platte River on the north side of Mineral. (Outfall capacity would increase from 260 cfs to 520 cfs.) The outfall to Dad Clark would increase the design discharge for Dad Clark Gulch from Santa Fe Drive to the South Platte Park. However, this effect would be minimal and therefore was not considered in the cost analysis.

Reach 2.2 - Increased detention at Mineral Avenue and the railroad lines so as to allow a 100-year release rate of 520 cfs, channel improvements upstream of Jackass Hill Road, detention in channel just downstream of the Highline Canal to reduce flow as needed downstream.

Reach 2.3 - No improvements to existing storm sewers or detention facilities.

ALTERNATIVE 2

Reach 2.1 - No improvements to outfall from lower detention pond.

Reach 2.2 - Same as Alternative 1 except the proposed detention ponds vary slightly in volume, and the lower detention pond will have a 100-year release rate of 260 cfs.

Reach 2.3 - Require existing private detention facilities.

ALTERNATIVE 3

Reach 2.1 - Same as proposed in Alternative 1.

Reach 2.2 - Same as Alternative 1 except the proposed detention ponds vary slightly in volume, and an overflow spillway will be installed on the Highline Canal to release a sustained discharge of 300 cfs into Jackass Gulch.

Reach 2.3 - Same as proposed in Alternative 2.

3.6.3 Lower Dad Clark Gulch

There are three major variables for the Lower Dad Clark Gulch alternatives: 1. the execution of an adequate assurances agreement for McLellan Reservoir as a flood control facility 2. the type of improvements downstream of Santa Fe Drive, (Low flow facilities in South Platte Park were designed for 100 cfs.), and 3. the option of either doing channel improvements upstream of the railroad tracks or not. (Subalternatives "A" do not consider channel improvements in this area.)

ALTERNATIVE 1A - Assumes no flood attenuation in McLellan Reservoir due to no adequate assurances agreement.

Reach 3.1 - Grass-lined channel extending from Santa Fe Drive to the South Platte Park boundary and designed for the 100-year flow of 1800 cfs, major channel phases out at the park boundary, continued flow separation at City Ditch, construction of a water quality pond just upstream of South Platte Park designed in accordance with Chapter 15 of Littleton Criteria, new storm sewer with existing ditch across South Platte Park to convey water quality pond releases.

Reach 3.2 - No improvements to channel.

ALTERNATIVE 2A

Reach 3.1 - Same as Alternative 1A but with the following exceptions: Major channel facilities designed for the 100-year flow of 850 cfs, (assumes an adequate assurances agreement has been executed for McLellan Reservoir) new low flow channel and maintenance access across South Platte Park instead of storm sewer and existing ditch.

Reach 3.2 - No improvements to channel.

ALTERNATIVE 3A

Reach 3.1 - Same as Alternative 2A, but with the following exceptions: wetlands bottom for major channel instead of grass-lined, (assumes an adequate assurances agreement has been executed for McLellan Reservoir), wetlands bottom low flow channel across South Platte Park.

Reach 3.2 - No improvements to channel.

ALTERNATIVE 1B - Assumes no flood attenuation in McLellan Reservoir due to no adequate assurances agreement.

Reach 3.1 - Same as proposed in Alternative 1A.

Reach 3.2 - Grass-lined channel designed for a 100-year flow of 1800 cfs.

ALTERNATIVE 2B

Reach 3.1 - Same as proposed in Alternative 2A.

Reach 3.2 - Same as Alternative 1B but with the following exceptions: Major channel facilities designed for the 100-year flow of 850 cfs, adequate assurances agreement for flood storage at McLellan Reservoir.

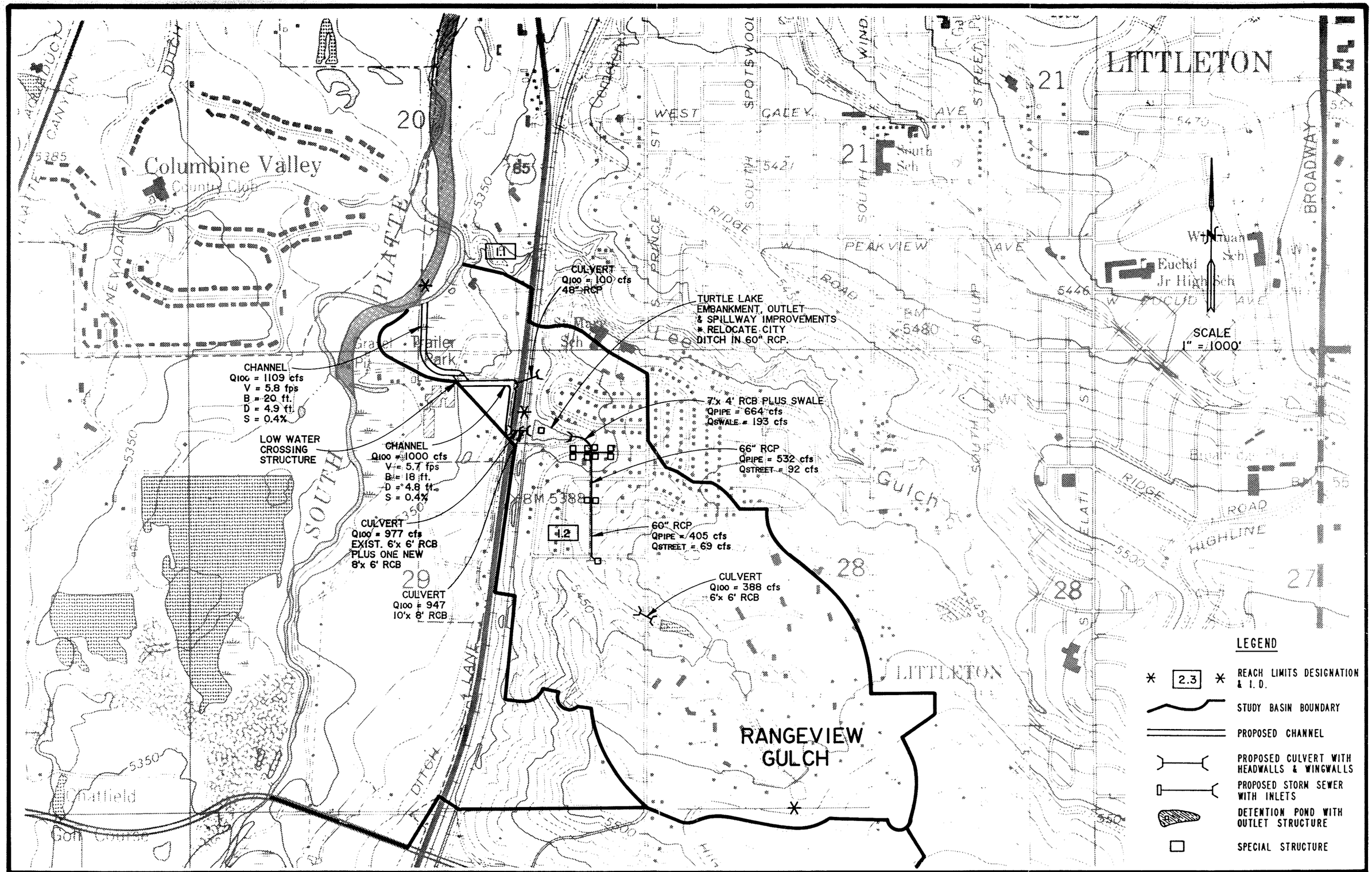
ALTERNATIVE 3B

Reach 3.1 - Same as proposed in Alternative 3A.

Reach 3.2 - Same as proposed in Alternative 2B.

3.7 Alternative Costs

The components of each alternative were sized based on the previously stated design criteria, and quantity take-offs were determined for the items listed in the unit cost tables. Right-of-way acquisition areas were costed out either based on zoning or as floodway areas. The land acquisition areas for each basin are listed as follows:



BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD / HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC	DESIGNED ____ DATE ____ DRAWN ____ DATE ____ CHECKED ____ DATE ____ REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	RANGEVIEW BASIN OUTFALL SYSTEM SCHEMATIC ALTERNATIVE 1	FIGURE 3-1a CEI JN 906.00

CULVERT
Q100 = 100 cfs
48" RCP

TURTLE LAKE
DETENTION IMPROVEMENTS
STORAGE = 10.3 ac. ft.
QR = 580 cfs
* RELOCATE CITY
DITCH IN 60" RCP

CHANNEL
Q100 = 768 cfs
V = 5.4 fps
B = 10 ft.
D = 4.8 ft.
S = 0.4%

LOW WATER
CROSSING
STRUCTURE

CHANNEL
Q100 = 626 cfs
V = 5.2 fps
B = 5 ft.
D = 4.9 ft.
S = 0.4%

66" RCP
QPIPE = 563 cfs
QSWALE = 200 cfs

66" RCP
QPIPE = 532 cfs
QSTREET = 92 cfs

CULVERT
Q100 = 626 cfs
EXIST. 6'x 6' RCB
PLUS 6'x 4' RCB

60" RCP
QPIPE = 405 cfs
QSTREET = 69 cfs

CULVERT
Q100 = 588 cfs
10'x 6' RCB

CULVERT
Q100 = 388 cfs
6'x 6' RCB

STORM SEWER
SYSTEM
36" RCP OUTFALL
Q100 = 95 cfs

RANGEVIEW
GULCH

SCALE
1" = 1000'

LEGEND

- REACH LIMITS DESIGNATION & I. D.
- STUDY BASIN BOUNDARY
- PROPOSED CHANNEL
- PROPOSED CULVERT WITH HEADWALLS & WINGWALLS
- PROPOSED STORM SEWER WITH INLETS
- DETENTION POND WITH OUTLET STRUCTURE
- SPECIAL STRUCTURE

BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC	DESIGNED ____ DATE ____ DRAWN ____ DATE ____ CHECKED ____ DATE ____ REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	RANGEVIEW BASIN OUTFALL SYSTEM SCHEMATIC ALTERNATIVE 2	FIGURE 3-1b CEI JN 906.00

CULVERT
Q100 = 496 cfs
8'x 6' RCB

CHANNEL
Q100 = 367 cfs
V = 4.5 fps
B = 5 ft.
D = 3.9 ft.
S = 0.4%

TURTLE LAKE AS
DETENTION FACILITY
STORAGE = 10.3 ac. ft.
QR = 358 cfs
* RELOCATE CITY
DITCH IN 60" RCP.

CHANNEL
Q100 = 637 cfs
V = 5.2 fps
B = 5 ft.
D = 5.0 ft.
S = 0.4%

LOW WATER
CROSSING
STRUCTURE

CHANNEL
Q100 = 496 cfs
V = 4.9 fps
B = 5 ft.
D = 4.5 ft.
S = 0.4%

SWALE
Q100 = 25 cfs
V = 2.3 fps
B = 2 ft.
D = 1.4 ft.

54" RCP
QPIPE = 364 cfs
QSWALE = 196 cfs

54" RCP
QPIPE = 318 cfs
QSTREET = 102 cfs

42" RCP
QPIPE = 143 cfs
QSTREET = 92 cfs

CULVERT
Q100 = 388 cfs
6'x 6' RCB

STORM SEWER
SYSTEM
36" RCP OUTFALL
Q100 = 95 cfs

RANGEVIEW PARK
DETENTION FACILITY
STORAGE = 8.8 ac. ft.
QR = 253 cfs

RANGEVIEW
GULCH

SCALE
1" = 1000'

LEGEND

- REACH LIMITS DESIGNATION & I. D.
- STUDY BASIN BOUNDARY
- PROPOSED CHANNEL
- PROPOSED CULVERT WITH HEADWALLS & WINGWALLS
- PROPOSED STORM SEWER WITH INLETS
- DETENTION POND WITH OUTLET STRUCTURE
- SPECIAL STRUCTURE

BASE MAP
UNITED STATES GEOLOGICAL SURVEY MAP
LITTLETON QUAD HIGHLANDS RANCH QUAD

CENTENNIAL ENGINEERING INC

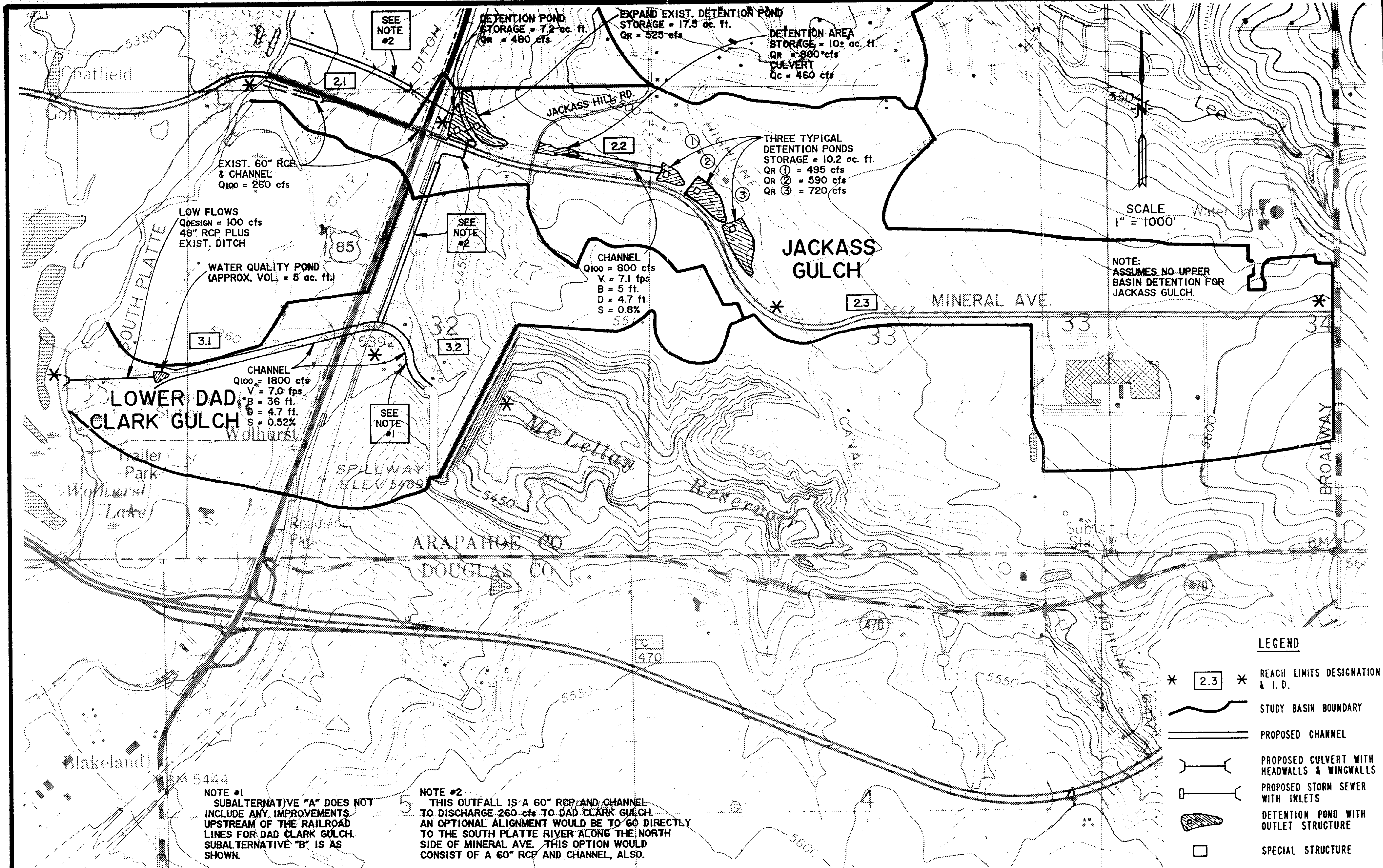
DESIGNED _____ DATE _____
DRAWN _____ DATE _____
CHECKED _____ DATE _____
REVISED _____ DATE _____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

RANGEVIEW BASIN
OUTFALL SYSTEM SCHEMATIC
ALTERNATIVE 3

FIGURE
3-Ic
CEI JN 906.00



DETENTION POND STORAGE = 7.2 ac. ft. QR = 480 cfs
EXPAND EXIST. DETENTION POND STORAGE = 17.5 ac. ft. QR = 525 cfs
DETENTION AREA STORAGE = 10± ac. ft. QR = 800 cfs CULVERT Qc = 460 cfs
SEE NOTE #2
JACKASS HILL RD.
THREE TYPICAL DETENTION PONDS STORAGE = 10.2 ac. ft. QR ① = 495 cfs QR ② = 590 cfs QR ③ = 720 cfs
EXIST. 60" RCP & CHANNEL Q100 = 260 cfs
LOW FLOWS QDESIGN = 100 cfs 48" RCP PLUS EXIST. DITCH
WATER QUALITY POND (APPROX. VOL. = 5 ac. ft.)
SCALE 1" = 1000'
CHANNEL Q100 = 800 cfs V = 7.1 fps B = 5 ft. D = 4.7 ft. S = 0.8%
JACKASS GULCH
NOTE: ASSUMES NO UPPER BASIN DETENTION FOR JACKASS GULCH.
MINERAL AVE.
CHANNEL Q100 = 1800 cfs V = 7.0 fps B = 36 ft. D = 4.7 ft. S = 0.52%
LOWER DAD CLARK GULCH
SEE NOTE #1
SPILLWAY ELEV 5489
McLellan Reservoir
ARAPAHOE CO
DOUGLAS CO
BROADWAY
SOUTH PLATTE
CANAL
Chatfield
Wolhurst
Trailer Park
Lakeland
2.1
2.2
2.3
3.1
3.2
NOTE #1
SUBALTERNATIVE "A" DOES NOT INCLUDE ANY IMPROVEMENTS UPSTREAM OF THE RAILROAD LINES FOR DAD CLARK GULCH. SUBALTERNATIVE "B" IS AS SHOWN.
NOTE #2
THIS OUTFALL IS A 60" RCP AND CHANNEL TO DISCHARGE 260 cfs TO DAD CLARK GULCH. AN OPTIONAL ALIGNMENT WOULD BE TO GO DIRECTLY TO THE SOUTH PLATTE RIVER ALONG THE NORTH SIDE OF MINERAL AVE. THIS OPTION WOULD CONSIST OF A 60" RCP AND CHANNEL, ALSO.
LEGEND
REACH LIMITS DESIGNATION & I.D.
STUDY BASIN BOUNDARY
PROPOSED CHANNEL
PROPOSED CULVERT WITH HEADWALLS & WINGWALLS
PROPOSED STORM SEWER WITH INLETS
DETENTION POND WITH OUTLET STRUCTURE
SPECIAL STRUCTURE

BASE MAP	CENTENNIAL ENGINEERING INC	DESIGNED ___ DATE ___ DRAWN ___ DATE ___ CHECKED ___ DATE ___ REVISED ___ DATE ___	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING	JACKASS & LOWER DAD CLARK BASINS OUTFALL SYSTEM SCHEMATIC	FIGURE 3-2a
UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD HIGHLANDS RANCH QUAD			CITY OF LITTLETON	LOWER DAD CLARK GULCH AND DFA 0068	ALTERNATIVE 1	CEI JN 906.00

DETENTION POND
STORAGE = 7.2 ac. ft.
QR = 239 cfs

EXPAND EXIST. DETENTION POND
STORAGE = 17.5 ac. ft.
QR = 270 cfs

DETENTION POND
STORAGE = 4.4 ac. ft.
QR = 400 cfs
CULVERT
Qc = 460 cfs

DETENTION POND
STORAGE = 7.0 ac. ft.
QR ① = 200 cfs

TWO TYPICAL
DETENTION PONDS
STORAGE = 11.4 ac. ft.
QR ② = 225 cfs
QR ③ = 275 cfs

EXIST. 60" RCP
& CHANNEL
Q100 = 260 cfs

LOW FLOW CHANNEL
QDESIGN = 100 cfs
V = 3.3 fps
B = 2 ft.
D = 2.5 ft.

WATER QUALITY POND
(APPROX. VOL. = 5 ac. ft.)

CHANNEL
Q100 = 400 cfs
V = 6.2 fps
B = 5 ft.
D = 3.4 ft.
S = 0.9%

CHANNEL & DROP
Q100 = 850 cfs
V = 4.9 fps
B = 15 ft.
D = 5.0 ft.
S = 0.3%

ADEQUATE ASSURANCES
AGREEMENT ON
McLELLAN

SEE NOTE #1

JACKASS GULCH

LOWER DAD CLARK GULCH

2.1 2.2 2.3 3.1 3.2

JACKASS HILL RD.

MINERAL AVE.

SOUTH PLATTE

SPILLWAY ELEV 5489

ARAPAHOE CO
DOUGLAS CO

PIPELINE

SCALE
1" = 1000'

NOTE:
ASSUMES UPPER
BASIN DETENTION FOR
JACKASS GULCH.

NOTE #1
SUBALTERNATIVE "A" DOES NOT INCLUDE ANY IMPROVEMENTS UPSTREAM OF THE RAILROAD LINES FOR DAD CLARK GULCH. SUBALTERNATIVE "B" IS AS SHOWN.

LEGEND

- 2.3 — REACH LIMITS DESIGNATION & I.D.
- STUDY BASIN BOUNDARY
- PROPOSED CHANNEL
- PROPOSED CULVERT WITH HEADWALLS & WINGWALLS
- PROPOSED STORM SEWER WITH INLETS
- DETENTION POND WITH OUTLET STRUCTURE
- SPECIAL STRUCTURE

BASE MAP
UNITED STATES GEOLOGICAL SURVEY MAP
LITTLETON QUAD HIGHLANDS RANCH QUAD

CENTENNIAL ENGINEERING INC

DESIGNED ____ DATE ____
DRAWN ____ DATE ____
CHECKED ____ DATE ____
REVISED ____ DATE ____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

JACKASS & LOWER
DAD CLARK BASINS
OUTFALL SYSTEM SCHEMATIC
ALTERNATIVE 2

FIGURE
3-2b
CEI JN 906.00

SEE NOTE #2

DETENTION POND
STORAGE = 7.2 ac. ft.
Q_R = 530 cfs

EXPAND EXIST. DETENTION POND
STORAGE = 17.5 ac. ft.
Q_R = 570 cfs

DETENTION AREA
STORAGE = 10± ac. ft.
Q_R = 600 cfs
CULVERT
Q_C = 460 cfs

2.1

JACKASS HILL RD.

2.2

THREE TYPICAL
DETENTION PONDS
STORAGE = 11.4 ac. ft.
Q_R ① = 485 cfs
Q_R ② = 525 cfs
Q_R ③ = 575 cfs

EXIST. 60" RCP
& CHANNEL
Q_{100} = 260 cfs

LOW FLOWS
w/WETLANDS
Q_{DESIGN} = 100 cfs
V = 2.1 fps
B = 5 ft.
D = 3.2 ft.

WATER QUALITY POND
(APPROX. VOL. = 5 ac. ft.)

SEE NOTE #2

CHANNEL
Q_{100} = 850 cfs
V = 4.9 fps
B = 15 ft.
D = 5.0 ft.
S = 0.3%

CHANNEL
Q_{100} = 800 cfs
V = 7.1 fps
B = 5 ft.
D = 4.7 ft.
S = 0.8%

JACKASS GULCH

SCALE
1" = 1000'

NOTE:
ASSUMES UPPER
BASIN DETENTION FOR
JACKASS GULCH.

2.3

MINERAL AVE.

3.1

3.2

CHANNEL w/WETLANDS
Q_{100} = 850 cfs
V = 4.5 fps
B = 20 ft.
D = 4.8 ft.
S = 0.52%

LOWER DAD
CLARK GULCH

SEE NOTE #1

ADEQUATE ASSURANCES
AGREEMENT ON
McLELLAN

HIGHLAND CANAL
OVERFLOW SPILLWAY
(DESIGNED FOR A
SUSTAINED PEAK
DISCHARGE OF 300 cfs)

SPILLWAY
ELEV 5409

470

LEGEND

- 2.3 — REACH LIMITS DESIGNATION & I.D.
- STUDY BASIN BOUNDARY
- PROPOSED CHANNEL
- PROPOSED CULVERT WITH HEADWALLS & WINGWALLS
- PROPOSED STORM SEWER WITH INLETS
- DETENTION POND WITH OUTLET STRUCTURE
- SPECIAL STRUCTURE

NOTE #1
SUBALTERNATIVE "A" DOES NOT INCLUDE ANY IMPROVEMENTS UPSTREAM OF THE RAILROAD LINES FOR DAD CLARK GULCH. SUBALTERNATIVE "B" IS AS SHOWN.

NOTE #2
THIS OUTFALL IS A 60" RCP AND CHANNEL TO DISCHARGE 260 cfs TO DAD CLARK GULCH. AN OPTIONAL ALIGNMENT WOULD BE TO GO DIRECTLY TO THE SOUTH PLATTE RIVER ALONG THE NORTH SIDE OF MINERAL AVE. THIS OPTION WOULD CONSIST OF A 60" RCP AND CHANNEL, ALSO.

BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LITTLETON QUAD HIGHLANDS RANCH QUAD	CENTENNIAL ENGINEERING INC	DESIGNED ____ DATE ____ DRAWN ____ DATE ____ CHECKED ____ DATE ____ REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LITTLETON	OUTFALL SYSTEMS PLANNING LOWER DAD CLARK GULCH AND DFA 0068	JACKASS & LOWER DAD CLARK BASINS OUTFALL SYSTEM SCHEMATIC ALTERNATIVE 3	FIGURE 3-2c CEI JN 906.00

Rangeview

- Turtle Lake, if used for detention, was considered floodway property.
- The swale just upstream of Turtle Lake and channels downstream of Turtle Lake were costed out as property is presently zoned.

- No acquisition upstream of Costilla Avenue.

Jackass

- Existing detention ponds on private property were assumed to be floodway property.

- A 60' wide channel area from the future Equestrian Park (which is located in the NW corner of Mineral Avenue and the Highline Canal) to Jackass Hill Road was assumed to be floodway property.

- Improvements in the future Equestrian Park just down stream of the Highline Canal were assumed to be on public property.

- The existing detention area downstream of Jackass Hill Road is currently on public easement.

- All other channel and detention areas were costed out as property is presently zoned, (no acquisition in South Platte Park).

Dad Clark Gulch

- The entire channel area from the spillway of McLellan Reservoir to the South Platte Park was considered floodway property, (no acquisition in South Platte Park).

Estimated costs were calculated for each basin for each of the three alternatives. The results are listed in Tables 3-4, 3-5, and 3-6.

3.8 Alternative Evaluation Matrix

Each alternative was evaluated on four criteria: cost, constructibility, flood control, and environmental issues. Maintenance accessibility was included in the design of all facilities by considering needed right-of-way and maintenance road, if necessary.

Cost -- The cost of an alternative is a combination of three components -construction, right-of-way, and maintenance. Construction and right-of-way are associated with the initial alternative cost and are listed as a combined item in the table along with the maintenance cost.

Constructibility -- Constructibility was evaluated on a comparison basis of each of the three alternatives. This item includes possible problems with right-of-way acquisition, accessibility of the construction area, and the complexity of construction.

Flood Control -- Flood control was evaluated on an adequate/inadequate basis depending on if the improvements eliminate flooding for the 100-year event. Flood control was considered adequate if flows were confined in a channel or street right-of-way.

Environmental Issues -- Environmental issues include aesthetic, recreational and water quality aspects. This item, like constructibility, was evaluated on a comparison basis between the alternatives. William Wenk Associates have conducted a site review of the study area. Their recommendations are contained in a memorandum (dated December 19, 1989) located in Appendix B.

A summary of the evaluation is shown in Table 3-7 and a brief discussion of each basin follows. Flood control was considered adequate for all alternatives. The only minor flooding was street flooding down Curtice Street on Rangeview Gulch (less than a half foot above the street crown) and weir overflow across Jackass Hill Road (less than one foot above road).

Rangeview Gulch -- All of the alternatives for Rangeview Gulch are much the same except that Alternative 3 is more cost effective. Constructibility is not considered "GOOD" since Turtle Lake is not easily accessible.

Jackass Gulch -- For Jackass Gulch, Alternative 2 is good for both constructibility and environmental issues where as, Alternatives 1 and 3 do not rate as high in either of these categories due to the additional outfall system. Alternative 2 is also the most cost effective. When comparing these alternatives, it is important to keep in mind that Alternative 3 is the only alternative which takes storm flows out of Highline Canal in order to reduce flooding of Lee Gulch.

Lower Dad Clark Gulch -- Lower Dad Clark Gulch alternatives are all about the same on constructibility. Subalternatives "A" are more cost effective and have less environmental impacts than Subalternatives "B" since Subalternatives "A" propose no channel improvements upstream of the railroad tracks. Alternatives "3" are comparatively better due to the wetlands which are proposed.

TABLE 3-4
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: RANGEVIEW GULCH

ITEM	UNITS	UNIT COST	ALTERNATIVE 1 QUANTITY	ALTERNATIVE 1 EXTENSION	ALTERNATIVE 2 QUANTITY	ALTERNATIVE 2 EXTENSION	ALTERNATIVE 3 QUANTITY	ALTERNATIVE 3 EXTENSION
Excavation	CY	5	21,583.0	107,915.00	16,169.0	80,845.00	13,782.0	68,910.00
Embankment	CY	4	511.0	2,044.00	4,090.0	16,360.00	7,413.0	29,652.00
Clearing & Grubbing	AC	2,000	6.1	12,200.00	5.5	11,000.00	6.6	13,200.00
Restoration (top soil, grading and revegetation)	AC	2,500	6.1	15,250.00	5.5	13,750.00	6.6	16,500.00
Wetlands Restoration								
General Channel Areas	AC	5,000	-	0.00	-	0.00	-	0.00
South Platte Park Area	AC	25,000	-	0.00	-	0.00	-	0.00
Maintenance Road	LF	25	-	0.00	-	0.00	-	0.00
Trickle Channel	LF	20	2,050.0	41,000.00	2,050.0	41,000.00	2,100.0	42,000.00
Riprap and Bedding	CY	50	1,759.0	87,950.00	1,594.0	79,700.00	1,080.0	54,000.00
Concrete Drop Structure - 3 feet (excavation, concrete wall, footing, backfill & riprap)	LF	225	718.0	161,550.00	607.0	136,575.00	467.0	105,075.00
Outlet Works (emergency spillway, concrete outlet structure, trash rack, outlet pipe, energy dissipator)								
Small Pond (6 ac-ft)	EA	30,000	1.0	30,000.00	1.0	30,000.00	1.0	30,000.00
Medium Pond (10 ac-ft)	EA	40,000	1.0	40,000.00	1.0	40,000.00	1.0	40,000.00
Large Pond (20 ac-ft)	EA	45,000	-	0.00	-	0.00	-	0.00
Low Water Crossing Structure	EA	5,000	1.0	5,000.00	1.0	5,000.00	1.0	5,000.00
Reinforced Concrete Pipe (excavation, bedding, backfill manholes, and inlets)								
30 inch	LF	75	-	0.00	500.0	37,500.00	500.0	37,500.00
36 inch	LF	90	-	0.00	400.0	36,000.00	400.0	36,000.00
42 inch	LF	110	-	0.00	-	0.00	600.0	66,000.00
48 inch	LF	130	300.0	39,000.00	300.0	39,000.00	-	0.00
54 inch	LF	150	-	0.00	-	0.00	950.0	142,500.00
60 inch	LF	175	1,000.0	175,000.00	1,000.0	175,000.00	400.0	70,000.00
66 inch	LF	190	650.0	123,500.00	950.0	180,500.00	-	0.00
72 inch	LF	210	-	0.00	-	0.00	-	0.00
78 inch	LF	250	-	0.00	-	0.00	-	0.00
Reinforced Concrete Culverts (excavation, bedding, backfill headwall, and wingwalls)								
4'x 4' RCB	LF	200	-	0.00	-	0.00	-	0.00
6'x 4' RCB	LF	250	-	0.00	200.0	50,000.00	-	0.00
6'x 6' RCB	LF	290	200.0	58,000.00	200.0	58,000.00	200.0	58,000.00
7'x 4' RCB	LF	300	300.0	90,000.00	-	0.00	-	0.00
8'x 6' RCB	LF	430	200.0	86,000.00	-	0.00	300.0	129,000.00
8'x 8' RCB	LF	470	-	0.00	-	0.00	-	0.00

TABLE 3-4
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: RANGEVIEW GULCH

ITEM	UNITS	UNIT COST	ALTERNATIVE 1 QUANTITY	ALTERNATIVE 1 EXTENSION	ALTERNATIVE 2 QUANTITY	ALTERNATIVE 2 EXTENSION	ALTERNATIVE 3 QUANTITY	ALTERNATIVE 3 EXTENSION
10'x 6' RCB	LF	600	-	0.00	80.0	48,000.00	-	0.00
10'x 8' RCB	LF	660	80.0	52,800.00	-	0.00	-	0.00
10'x10' RCB	LF	720	-	0.00	-	0.00	-	0.00
12'x 8' RCB	LF	780	-	0.00	-	0.00	-	0.00
12'x10' RCB	LF	840	-	0.00	-	0.00	-	0.00
12'x12' RCB	LF	900	-	0.00	-	0.00	-	0.00
Jacking Cost								
48" RCP	LF	520	100.0	52,000.00	100.0	52,000.00	-	0.00
60" RCP	LF	700	-	0.00	-	0.00	-	0.00
8'x 6' RCB	LF	1,720	-	0.00	-	0.00	100.0	172,000.00
10'x 6' RCB	LF	2,400	-	0.00	80.0	192,000.00	-	0.00
10'x 8' RCB	LF	2,640	80.0	211,200.00	-	0.00	-	0.00
SUBTOTAL				1,390,409.00		1,322,230.00		1,115,337.00
Engineering, Legal and Administrative, Utility Relocation (35%)				486,643.15		462,780.50		390,367.95
Contingency (15%)				208,561.35		198,334.50		167,300.55
TOTAL CONSTRUCTION COST				2,085,613.50		1,983,345.00		1,673,005.50
Land Value								
Floodway Property	AC	4,500	-	0.00	2.7	12,150.00	2.7	12,150.00
Residential	AC	40,000	1.7	68,000.00	1.4	56,000.00	1.4	56,000.00
Industrial	AC	85,000	-	0.00	-	0.00	-	0.00
Retail Commercial	AC	130,000	1.7	221,000.00	1.5	195,000.00	1.3	169,000.00
LAND ACQUISITION COST				289,000.00		263,150.00		237,150.00
TOTAL PROJECT COST				2,374,613.50		2,246,495.00		1,910,155.50
ANNUAL ROUTINE MAINTENANCE COSTS:								
Mowing (3 times/year)	AC	1,000	7.4	7,400.00	9.6	9,600.00	9.4	9,400.00
Debris and Trash Removal (3 times/year)	AC	250	7.4	1,850.00	9.6	2,400.00	9.4	2,350.00
Detention Area Sediment Removal (once/year)	LS	1,000	2.0	2,000.00	2.0	2,000.00	2.0	2,000.00
Storm Sewer Cleaning and Debris Removal (once/year)	LF	0.3	2,930.0	879.00	3,430.0	1,029.00	3,750.0	1,125.00
TOTAL MAINTENANCE COST				12,129.00		15,029.00		14,875.00

TABLE 3-5
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: JACKASS GULCH

ITEM	UNITS	UNIT COST	ALTERNATIVE 1 * QUANTITY	ALTERNATIVE 1 * EXTENSION	ALTERNATIVE 2 QUANTITY	ALTERNATIVE 2 EXTENSION	ALTERNATIVE 3 * QUANTITY	ALTERNATIVE 3 * EXTENSION
Excavation	CY	5	82,300.0	411,500.00	62,900.0	314,500.00	82,300.0	411,500.00
Embankment	CY	4	39,640.0	158,560.00	17,600.0	70,400.00	39,640.0	158,560.00
Clearing & Grubbing	AC	2,000	23.0	46,000.00	18.3	36,600.00	23.0	46,000.00
Restoration (top soil, grading and revegetation)	AC	2,500	20.9	52,250.00	16.2	40,500.00	20.9	52,250.00
Wetlands Restoration								
General Channel Areas	AC	5,000	2.1	10,500.00	2.1	10,500.00	2.1	10,500.00
South Platte Park Area	AC	25,000	-	0.00	-	0.00	-	0.00
Maintenance Road	LF	25	5,350.0	133,750.00	3,750.0	93,750.00	5,350.0	133,750.00
Trickle Channel	LF	20	4,450.0	89,000.00	2,900.0	58,000.00	4,450.0	89,000.00
Riprap and Bedding	CY	50	717.0	35,850.00	422.0	21,100.00	717.0	35,850.00
Concrete Drop Structure - 3 feet (excavation, concrete wall, footing, backfill & riprap)	LF	225	1,059.0	238,275.00	788.0	177,300.00	1,059.0	238,275.00
Outlet Works (emergency spillway, concrete outlet structure, trash rack, outlet pipe, energy dissipator)								
Small Pond (6 ac-ft)	EA	30,000	-	0.00	2.0	60,000.00	-	0.00
Medium Pond (10 ac-ft)	EA	40,000	3.0	120,000.00	2.0	80,000.00	3.0	120,000.00
Large Pond (20 ac-ft)	EA	45,000	1.0	45,000.00	-	0.00	1.0	45,000.00
Highline Canal Overflow Spillway	LS	30,000	-	0.00	-	0.00	1.0	30,000.00
Reinforced Concrete Pipe (excavation, bedding, backfill manholes, and inlets)								
30 inch	LF	75	-	0.00	-	0.00	-	0.00
36 inch	LF	90	-	0.00	-	0.00	-	0.00
42 inch	LF	110	-	0.00	-	0.00	-	0.00
48 inch	LF	130	-	0.00	-	0.00	-	0.00
54 inch	LF	150	-	0.00	-	0.00	-	0.00
60 inch	LF	175	880.0	154,000.00	-	0.00	880.0	154,000.00
66 inch	LF	190	-	0.00	-	0.00	-	0.00
72 inch	LF	210	-	0.00	-	0.00	-	0.00
78 inch	LF	250	-	0.00	-	0.00	-	0.00
Reinforced Concrete Culverts (excavation, bedding, backfill headwall, and wingwalls)								
4'x 4' RCB	LF	200	-	0.00	-	0.00	-	0.00
6'x 4' RCB	LF	250	-	0.00	-	0.00	-	0.00
6'x 6' RCB	LF	290	-	0.00	-	0.00	-	0.00
7'x 4' RCB	LF	300	-	0.00	-	0.00	-	0.00
8'x 6' RCB	LF	430	-	0.00	-	0.00	-	0.00
8'x 8' RCB	LF	470	-	0.00	-	0.00	-	0.00
10'x 6' RCB	LF	600	-	0.00	-	0.00	-	0.00

TABLE 3-5
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: JACKASS GULCH

ITEM	UNITS	UNIT COST	ALTERNATIVE 1 * QUANTITY	ALTERNATIVE 1 * EXTENSION	ALTERNATIVE 2 QUANTITY	ALTERNATIVE 2 EXTENSION	ALTERNATIVE 3 * QUANTITY	ALTERNATIVE 3 * EXTENSION
10'x 8' RCB	LF	660	-	0.00	-	0.00	-	0.00
10'x10' RCB	LF	720	-	0.00	-	0.00	-	0.00
12'x 8' RCB	LF	780	-	0.00	-	0.00	-	0.00
12'x10' RCB	LF	840	-	0.00	-	0.00	-	0.00
12'x12' RCB	LF	900	-	0.00	-	0.00	-	0.00
Jacking Cost								
48" RCP	LF	520	-	0.00	-	0.00	-	0.00
60" RCP	LF	700	-	0.00	-	0.00	-	0.00
8'x 6' RCB	LF	1,720	-	0.00	-	0.00	-	0.00
10'x 6' RCB	LF	2,400	-	0.00	-	0.00	-	0.00
10'x 8' RCB	LF	2,640	-	0.00	-	0.00	-	0.00
SUBTOTAL				1,494,685.00		962,650.00		1,524,685.00
Engineering, Legal and Administrative, Utility Relocation (35%)				523,139.75		336,927.50		533,639.75
Contingency (15%)				224,202.75		144,397.50		228,702.75
TOTAL CONSTRUCTION COST				2,242,027.50		1,443,975.00		2,287,027.50
Land Value								
Floodway Property	AC	4,500	3.4	15,300.00	38.9	175,050.00	39.3	176,850.00
Residential	AC	40,000	10.6	424,000.00	6.9	276,000.00	10.6	424,000.00
Industrial	AC	85,000	-	0.00	-	0.00	-	0.00
Retail Commercial	AC	130,000	-	0.00	-	0.00	-	0.00
LAND ACQUISITION COST				439,300.00		451,050.00		600,850.00
TOTAL PROJECT COST				2,681,327.50		1,895,025.00		2,887,877.50
ANNUAL ROUTINE MAINTENANCE COSTS:								
Mowing (3 times/year)	AC	1,000	21.4	21,400.00	17.8	17,800.00	21.4	21,400.00
Debris and Trash Removal (3 times/year)	AC	250	21.4	5,350.00	17.8	4,450.00	21.4	5,350.00
Detention Area Sediment Removal (once/year)	LS	1,000	5.0	5,000.00	5.0	5,000.00	5.0	5,000.00
Storm Sewer Cleaning and Debris Removal (once/year)	LF	0.3	2,790.0	837.00	1,910.0	573.00	2,790.0	837.00
TOTAL MAINTENANCE COST				32,587.00		27,823.00		32,587.00

* Alternatives 1 & 3 are based on an outfall system to Dad Clark Gulch. The option of going directly to the South Platte River would be similar in cost.

TABLE 3-6
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: LOWER DAD CLARK

ITEM	UNITS	UNIT COST	ALTERNATIVE 1A QUANTITY	ALTERNATIVE 1A EXTENSION	ALTERNATIVE 2A QUANTITY	ALTERNATIVE 2A EXTENSION	ALTERNATIVE 3A QUANTITY	ALTERNATIVE 3A EXTENSION
Excavation	CY	5	30,760.0	153,800.00	21,134.0	105,670.00	21,643.0	108,215.00
Embankment	CY	4	17.0	68.00	17.0	68.00	17.0	68.00
Clearing & Grubbing	AC	2,000	7.7	15,400.00	7.1	14,200.00	7.5	15,000.00
Restoration (top soil, grading and revegetation)	AC	2,500	6.7	16,750.00	6.1	15,250.00	4.2	10,500.00
Wetlands Restoration								
General Channel Areas	AC	5,000	-	0.00	-	0.00	2.3	11,500.00
South Platte Park Area	AC	25,000	1.0	25,000.00	1.0	25,000.00	1.0	25,000.00
Maintenance Road	LF	25	3,350.0	83,750.00	3,350.0	83,750.00	3,350.0	83,750.00
Trickle Channel	LF	20	2,300.0	46,000.00	3,350.0	67,000.00	-	0.00
Riprap and Bedding	CY	50	4,511.0	225,550.00	4,541.0	227,050.00	4,541.0	227,050.00
Concrete Drop Structure - 3 feet (excavation, concrete wall, footing, backfill & riprap)	LF	225	-	0.00	126.0	28,350.00	-	0.00
Outlet Works (emergency spillway, concrete outlet structure, trash rack, outlet pipe, energy dissipator)								
Small Pond (6 ac-ft)	EA	30,000	1.0	30,000.00	1.0	30,000.00	1.0	30,000.00
Medium Pond (10 ac-ft)	EA	40,000	-	0.00	-	0.00	-	0.00
Large Pond (20 ac-ft)	EA	45,000	-	0.00	-	0.00	-	0.00
Reinforced Concrete Pipe (excavation, bedding, backfill manholes, and inlets)								
30 inch	LF	75	-	0.00	-	0.00	-	0.00
36 inch	LF	90	1,050.0	94,500.00	-	0.00	-	0.00
42 inch	LF	110	-	0.00	-	0.00	-	0.00
48 inch	LF	130	-	0.00	-	0.00	-	0.00
54 inch	LF	150	-	0.00	-	0.00	-	0.00
60 inch	LF	175	-	0.00	-	0.00	-	0.00
66 inch	LF	190	-	0.00	-	0.00	-	0.00
72 inch	LF	210	-	0.00	-	0.00	-	0.00
78 inch	LF	250	-	0.00	-	0.00	-	0.00
Reinforced Concrete Culverts (excavation, bedding, backfill headwall, and wingwalls)								
4'x 4' RCB	LF	200	-	0.00	-	0.00	-	0.00
6'x 4' RCB	LF	250	-	0.00	-	0.00	-	0.00
6'x 6' RCB	LF	290	-	0.00	-	0.00	-	0.00
7'x 4' RCB	LF	300	-	0.00	-	0.00	-	0.00
8'x 6' RCB	LF	430	-	0.00	-	0.00	-	0.00
8'x 8' RCB	LF	470	-	0.00	-	0.00	-	0.00
10'x 6' RCB	LF	600	-	0.00	-	0.00	-	0.00

TABLE 3-6
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: LOWER DAD CLARK

ITEM	UNITS	UNIT COST	ALTERNATIVE 1A QUANTITY	ALTERNATIVE 1A EXTENSION	ALTERNATIVE 2A QUANTITY	ALTERNATIVE 2A EXTENSION	ALTERNATIVE 3A QUANTITY	ALTERNATIVE 3A EXTENSION
10'x 8' RCB	LF	660	-	0.00	-	0.00	-	0.00
10'x10' RCB	LF	720	-	0.00	-	0.00	-	0.00
12'x 8' RCB	LF	780	-	0.00	-	0.00	-	0.00
12'x10' RCB	LF	840	-	0.00	-	0.00	-	0.00
12'x12' RCB	LF	900	-	0.00	-	0.00	-	0.00
Jacking Cost								
48" RCP	LF	520	-	0.00	-	0.00	-	0.00
60" RCP	LF	700	-	0.00	-	0.00	-	0.00
8'x 6' RCB	LF	1,720	-	0.00	-	0.00	-	0.00
10'x 6' RCB	LF	2,400	-	0.00	-	0.00	-	0.00
10'x 8' RCB	LF	2,640	-	0.00	-	0.00	-	0.00
SUBTOTAL				690,818.00		596,338.00		511,083.00
Engineering, Legal and Administrative, Utility Relocation (35%)				241,786.30		208,718.30		178,879.05
Contingency (15%)				103,622.70		89,450.70		76,662.45
TOTAL CONSTRUCTION COST				1,036,227.00		894,507.00		766,624.50
Land Value								
Floodway Property	AC	4,500	5.0	22,500.00	3.9	17,550.00	3.9	17,550.00
Residential	AC	40,000	-	0.00	-	0.00	-	0.00
Industrial	AC	85,000	-	0.00	-	0.00	-	0.00
Retail Commercial	AC	130,000	-	0.00	-	0.00	-	0.00
LAND ACQUISITION COST				22,500.00		17,550.00		17,550.00
TOTAL PROJECT COST				1,058,727.00		912,057.00		784,174.50
ANNUAL ROUTINE MAINTENANCE COSTS:								
Mowing (3 times/year)	AC	1,000	4.9	4,900.00	3.8	3,800.00	3.3	3,300.00
Debris and Trash Removal (3 times/year)	AC	250	4.9	1,225.00	3.8	950.00	3.3	825.00
Detention Area Sediment Removal (once/year)	LS	1,000	1.0	1,000.00	1.0	1,000.00	1.0	1,000.00
Storm Sewer Cleaning and Debris Removal (once/year)	LF	0.3	1,050.0	315.00	-	0.00	-	0.00
TOTAL MAINTENANCE COST				7,440.00		5,750.00		5,125.00

TABLE 3-6
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: LOWER DAD CLARK

ITEM	UNITS	UNIT COST	ALTERNATIVE 1B QUANTITY	ALTERNATIVE 1B EXTENSION	ALTERNATIVE 2B QUANTITY	ALTERNATIVE 2B EXTENSION	ALTERNATIVE 3B QUANTITY	ALTERNATIVE 3B EXTENSION
Excavation	CY	5	52,804.0	264,020.00	35,000.0	175,000.00	35,509.0	177,545.00
Embankment	CY	4	17.0	68.00	17.0	68.00	17.0	68.00
Clearing & Grubbing	AC	2,000	12.3	24,600.00	11.0	22,000.00	11.4	22,800.00
Restoration (top soil, grading and revegetation)	AC	2,500	11.3	28,250.00	10.0	25,000.00	8.1	20,250.00
Wetlands Restoration								
General Channel Areas	AC	5,000	-	0.00	-	0.00	2.3	11,500.00
South Platte Park Area	AC	25,000	1.0	25,000.00	1.0	25,000.00	1.0	25,000.00
Maintenance Road	LF	25	4,950.0	123,750.00	4,950.0	123,750.00	4,950.0	123,750.00
Trickle Channel	LF	20	3,900.0	78,000.00	4,950.0	99,000.00	1,600.0	32,000.00
Riprap and Bedding	CY	50	4,511.0	225,550.00	4,541.0	227,050.00	4,541.0	227,050.00
Concrete Drop Structure - 3 feet (excavation, concrete wall, footing, backfill & riprap)	LF	225	168.0	37,800.00	315.0	70,875.00	189.0	42,525.00
Outlet Works (emergency spillway, concrete outlet structure, trash rack, outlet pipe, energy dissipator)								
Small Pond (6 ac-ft)	EA	30,000	1.0	30,000.00	1.0	30,000.00	1.0	30,000.00
Medium Pond (10 ac-ft)	EA	40,000	-	0.00	-	0.00	-	0.00
Large Pond (20 ac-ft)	EA	45,000	-	0.00	-	0.00	-	0.00
Reinforced Concrete Pipe (excavation, bedding, backfill manholes, and inlets)								
30 inch	LF	75	-	0.00	-	0.00	-	0.00
36 inch	LF	90	1,050.0	94,500.00	-	0.00	-	0.00
42 inch	LF	110	-	0.00	-	0.00	-	0.00
48 inch	LF	130	-	0.00	-	0.00	-	0.00
54 inch	LF	150	-	0.00	-	0.00	-	0.00
60 inch	LF	175	-	0.00	-	0.00	-	0.00
66 inch	LF	190	-	0.00	-	0.00	-	0.00
72 inch	LF	210	-	0.00	-	0.00	-	0.00
78 inch	LF	250	-	0.00	-	0.00	-	0.00
Reinforced Concrete Culverts (excavation, bedding, backfill headwall, and wingwalls)								
4'x 4' RCB	LF	200	-	0.00	-	0.00	-	0.00
6'x 4' RCB	LF	250	-	0.00	-	0.00	-	0.00
6'x 6' RCB	LF	290	-	0.00	-	0.00	-	0.00
7'x 4' RCB	LF	300	-	0.00	-	0.00	-	0.00
8'x 6' RCB	LF	430	-	0.00	-	0.00	-	0.00
8'x 8' RCB	LF	470	-	0.00	-	0.00	-	0.00
10'x 6' RCB	LF	600	-	0.00	-	0.00	-	0.00

TABLE 3-6
PRELIMINARY COST ESTIMATE

PROJECT: DAD CLARK GULCH - UD&FCD
BASIN: LOWER DAD CLARK

ITEM	UNITS	UNIT COST	ALTERNATIVE 1B QUANTITY	ALTERNATIVE 1B EXTENSION	ALTERNATIVE 2B QUANTITY	ALTERNATIVE 2B EXTENSION	ALTERNATIVE 3B QUANTITY	ALTERNATIVE 3B EXTENSION
10'x 8' RCB	LF	660	-	0.00	-	0.00	-	0.00
10'x10' RCB	LF	720	-	0.00	-	0.00	-	0.00
12'x 8' RCB	LF	780	-	0.00	-	0.00	-	0.00
12'x10' RCB	LF	840	-	0.00	-	0.00	-	0.00
12'x12' RCB	LF	900	-	0.00	-	0.00	-	0.00
Jacking Cost								
48" RCP	LF	520	-	0.00	-	0.00	-	0.00
60" RCP	LF	700	-	0.00	-	0.00	-	0.00
8'x 6' RCB	LF	1,720	-	0.00	-	0.00	-	0.00
10'x 6' RCB	LF	2,400	-	0.00	-	0.00	-	0.00
10'x 8' RCB	LF	2,640	-	0.00	-	0.00	-	0.00
SUBTOTAL				931,538.00		797,743.00		712,488.00
Engineering, Legal and Administrative, Utility Relocation (35%)				326,038.30		279,210.05		249,370.80
Contingency (15%)				139,730.70		119,661.45		106,873.20
TOTAL CONSTRUCTION COST				1,397,307.00		1,196,614.50		1,068,732.00
Land Value								
Floodway Property	AC	4,500	6.9	31,050.00	5.4	24,300.00	5.4	24,300.00
Residential	AC	40,000	-	0.00	-	0.00	-	0.00
Industrial	AC	85,000	-	0.00	-	0.00	-	0.00
Retail Commercial	AC	130,000	-	0.00	-	0.00	-	0.00
LAND ACQUISITION COST				31,050.00		24,300.00		24,300.00
TOTAL PROJECT COST				1,428,357.00		1,220,914.50		1,093,032.00
ANNUAL ROUTINE MAINTENANCE COSTS:								
Mowing (3 times/year)	AC	1,000	8.0	8,000.00	6.1	6,100.00	5.6	5,600.00
Debris and Trash Removal (3 times/year)	AC	250	8.0	2,000.00	6.1	1,525.00	5.6	1,400.00
Detention Area Sediment Removal (once/year)	LS	1,000	1.0	1,000.00	1.0	1,000.00	1.0	1,000.00
Storm Sewer Cleaning and Debris Removal (once/year)	LF	0.3	1,050.0	315.00	-	0.00	-	0.00
TOTAL MAINTENANCE COST				11,315.00		8,625.00		8,000.00

TABLE 3-7
ALTERNATIVE EVALUATION MATRIX

	EVALUATION CRITERIA			
	COST Project Cost (Main. Cost)	CONSTRUCTIBILITY	100-YR FLOOD CONTROL	ENVIRONMENTAL ISSUES
RANGEVIEW GULCH				
Alternative 1	2,400,000 (12,000)	FAIR	ADEQUATE	FAIR
Alternative 2	2,200,000 (15,000)	FAIR	ADEQUATE	FAIR
Alternative 3	1,900,000 (15,000)	FAIR	ADEQUATE	FAIR
JACKASS GULCH				
Alternative 1	2,700,000 (32,500)	FAIR	ADEQUATE	POOR 2/
Alternative 2	1,900,000 (28,000)	GOOD	ADEQUATE	FAIR
	2,900,000 (32,500)	FAIR	ADEQUATE 1/	POOR 2/
LOWER DAD CLARK 3/				
Alternative 1A	1,100,000 (7,500)	GOOD	ADEQUATE	GOOD
Alternative 2A 4/	900,000 (6,000)	GOOD	ADEQUATE	GOOD
Alternative 3A 4/	800,000 (5,000)	GOOD	ADEQUATE	EXCELLENT
Alternative 1B	1,400,000 (11,500)	GOOD	ADEQUATE	FAIR
Alternative 2B 4/	1,200,000 (8,500)	GOOD	ADEQUATE	FAIR
Alternative 3B 4/	1,100,000 (8,000)	GOOD	ADEQUATE	GOOD

1/ 300 cfs of the Highline Canal storm flows is discharged into Jackass Gulch. This will have a positive effect on Lee Gulch.
2/ If the second outfall is directed east to the South Platte River, then a new discharge point will be established.
3/ Subalternatives "A" do not propose any improvements upstream of the railroad lines, whereas subalternatives "B" include channel improvements for that area.
4/ Assumes an adequate assurances agreement has been executed for McLellan Reservoir.

APPENDIX A

BACKGROUND INFORMATION

SUMMARY

BACKGROUND INFORMATION SUMMARY

Information	Source
REPORTS:	
"Final Drainage Report for Martin Marietta, Littleton Systems Center", prepared for Martin Marietta Aerospace, (Merrick & Company, Sept. 1983).	Littleton
"Final Drainage Report for Southpark Subdivision Filing No. 1", prepared for Southpark, A Joint Venture, (Merrick & Company, April 30, 1981).	Littleton
"Addendum to Final Drainage Report for Southpark Subdivision Filing No. 1", prepared for Southpark, A Joint Venture, (Merrick & Company, Oct. 4, 1983).	Littleton
Southpark Pond routing calculations for ponds "C", "E" and "F" for 2, 10, 100 year storms, (Merrick & Company, March 3, 1982).	Littleton
"Drainage Study for Southpark Subdivision, City of Littleton, CO", (Tri-Consultants, Feb. 1981, Revised June 1981).	Littleton
"Final Drainage Study for Southpark Subdivision Filing No. 11, City of Littleton, CO", prepared for the Writer Corporation, (Carroll & Lange, Inc., Feb. 13, 1987).	Littleton
"Final Drainage Report for Southpark Subdivision Filing, No. 5", prepared for Southpark, A Joint Venture, (Merrick & Company, Sept. 30, 1981).	Littleton
Southbridge I and II Office Buildings, Drainage Study, (KKBNA, April 3, 1981).	Littleton
Final Drainage Report for Southbridge Retail Center/ Southbridge Plaza, prepared for C.W. Fentress and Associates, (KKBNA, March 11, 1983, revised March 18, 1983).	Littleton
"Southbridge, Planned Unit Development", prepared for U.S. Home, (THK Associates, Inc., July 23, 1978).	Littleton

Information	Source
REPORTS:	
"Southbridge Filing No. 1, Littleton, CO, Final Drainage Study," prepared for US Home, (Gingery Associates, Feb. 9, 1979).	Littleon
"Southbridge Filing No. 4, Final Drainage Study, Littleton, CO", prepared for US Home, Inc., (Gingery Associates, Inc., June 29, 1981).	Littleton
"Drainage Report for Jackass Hill Road SID No. 84-1, Littleton, CO", prepared for City of Littleton, (KKBNA, Inc., August 1985, revised Oct. 1985).	Littleton
"Major Drainageway Planning, South Platte River, Chatfield Dam to Baseline Road", Phase A and Phase B, prepared for UD&FCD, (Wright Water Engineers, Inc., Aug. 1984 and Nov. 1985, respectively).	CEI Library
"Flood Hazard Area Delineation, Dad Clark Gulch", prepared for UD&FCD, Douglas County and Mission Viejo Company, (Jack G. Raub Company, Feb. 1980, revised Nov. 1980).	CEI Library
"Master Plan of Drainage, Dad Clark Gulch", prepared for Mission Viejo Company, (Jack G. Raub Company, the Nov. 1980 revised report and the July 1982 revised report).	Littleton
"Final Report on the Investigation of the 100-year Flood Plain on Dad Clark Gulch across the Santa Fe Park Development", prepared for Hardin & Company, (Sellards & Grigg, Inc.,	Littleton
March 1985) including UD&FCD letters to Littleton re: District review for maintenance assistance.	Littleton
"State Engineers Report on McLellan Dam, ID #80225", dated Oct. 28, 1983.	Littleton
"Phase I Inspection Report of McLellan Dam, Arapahoe County, CO", City of Englewood, ID #CO 01153, (U.S. Army Corps of Engineers, July 1978).	UD&FCD
"Highline Canal Master Plan, Lee Gulch to Little Dry Creek, Final Report", prepared for UD&FCD and Denver Board of Water Commissioners, (Leonard Rice Consultants, Nov. 1975).	UD&FCD

Information	Source
UTILITIES:	
License Agreements for Storm Sewer Utilities crossing the High Line Canal, Denver Water Department.	DWD
Culvert and bridge survey information.	Landmark Ltd.
CONSTRUCTION PLANS:	
"Mineral Avenue R.R. Separation", plan and profile of proposed Federal Aid Project No. M-1030-(3), State Highway #85, (Centennial Engineering, Inc., March 30, 1982), includes special revisions.	DeLeuw Cather & Company
Plan and Profile of Proposed Federal Aid Project No. CXFRU (GF) 10-0085-12, State Highway #85, (DeLeuw Cather & Company, Draft).	UD&FCD
Southbridge Filing No. 1 Storm Sewer Construction Drawings, prepared for US Home, (Gingery Associates, Inc., February 16, 1979, five sheets).	UD&FCD
Drainage Plan Lots 2 & 3, Block 2, Southbridge Filing No. 1, Littleton, CO, prepared for US Home, (Futura Engineering, Inc., Aug. 22, 1982, two sheets).	UD&FCD
North Highlands Ranch Parkway Culverts, Phase I, prepared for Highlands Ranch Metropolitan District No. 1, (Jack G. Raub Company, January 6, 1982, sheets 9, 10 and 11 of 11).	Littleton
Construction Plans for Highlands Ranch Filing No. 1, South Broadway Culvert and Plaza Drive (Canal Road) Culvert (Jack G. Raub Company, As built, (March 17, 1982, seven sheets).	UD&FCD
The New Town of Highlands Ranch, Culvert 22, prepared for Highlands Ranch Metropolitan District No. 1, (Jack G. Raub Company, March 1985, five sheets).	UD&FCD
Highlands Ranch Culvert 23, prepared for Highlands Ranch Metropolitan District No. 1, (Jack G. Raub Company, Dec. 1985, four sheets).	UD&FCD

CEI Library

Information	Source
CONSTRUCTION PLANS:	
The New Town of Highlands Ranch Culvert 12, prepared for Highlands Ranch Metropolitan District No. 1, (Jack G. Raub Company, Jan. 1986, sheets 12 and 13 of 13).	UD&FCD
Highlands Ranch Culvert No. 14, prepared for Highlands Ranch Metropolitan District No. 1, (Jack G. Raub Company, April 1987, sheets 14, 15 and 16 of 19).	UD&FCD
OTHER:	
Littleton City Limits map.	
City of Littleton Storm Drainage Basin Map, Figure 301, enlarged from Drainage Manual.	Littleton
City of Littleton Generalized Zoning Map, (Sept. 1987).	Littleton
City of Littleton Zoning Regulations, (1989).	Littleton
Copy of current FEMA Flood Insurance Study, Introductory pages, Discharge Table, and Flood Profiles for South Platte River, (Arapahoe County, CO) - obtained from UD&FCD, August 19, 1989.	UD&FCD
Landis Aerial Photo, Sept. 17, 1988.	CEI Library
Flood Insurance Rate Map, Community Panel Number 080017-0003C and 080017-0006C, (Feb. 3, 1981).	CEI Library
Flood Insurance Rate Map, Map Number 08005C-0065F and 08005C-0070F, (April 17, 1989).	CEI Library
USGS Quad Map, Highlands Ranch Quadrangle, (photo revised 1980).	CEI Library
USGS Quad Map, Littleton Quadrangle, (photo revised 1971).	CEI Library

	Information	Source
OTHER:		
	City of Littleton Storm Drainage Design and Technical Criteria, (WRC Engineering, Inc., Oct. 1986).	CEI Library
	Arapahoe County Storm Drainage Design and Technical Criteria, (WRC Engineering, Inc., Sept. 1985).	CEI Library
	Urban Storm Drainage Criteria Manual, (Wright-McLaughlin Engineers, 1969).	CEI Library
	Soil Survey of Arapahoe County, Colorado, Sheet No. 48, (USDA-SCS, March 1971).	UD&FCD
	CUHP EPC.EXE - Colorado Urban Hydrograph Procedure computer program - PC version, (Boyle Engineering Corp., Jan. 1985).	UD&FCD
	UDSWM 2PC.EXE - Environmental Protection Agency - Storm Water Management Model - Version PC.1, (METCALF + EDDY, Inc., Sept. 1970).	Littleton
	Rules and Regulations for Dam Safety and Dam Construction, (Division of Water Resources, State of Colorado, Aug. 26, 1988).	Littleton
	"Chapter 10 - Evaluation of Storm Water Treatment Alternatives for McLellan Reservoir", City of Englewood, (preliminary).	Littleton
	1/4 Section map of Equestrian Park Site at Mineral Ave. and the Highline Canal.	Littleton
	South Platte River Park Boundary Map, (Sutherland Engineers, Inc., July 7, 1980, two sheets) - not including latest land swap with Newton Trust.	Littleton
	Southpark PD General Plan by Emkay Development, Development plan and standards, (sheets 1 and 2 of 6, 1980).	Littleton
	Sante Fe Park PD, prepared for KC Ensor Realty Co., Conceptual Master Plan and development standards, (Rahenkamp/Oldham, Inc., sheets 1 and 6 of 7, Feb. 25, 1985).	CEI Library

Information	Source
OTHER:	
Santa Fe/South Platte Joint Use Corridor Plan prepared by DHM, Inc. & Urban Edges, Inc. - not dated.	Littleton
"Santa Fe Corridor Study Policies", (revised 1988, four pages).	Littleton
Santa Fe Drive Corridor Study Zoning Plan", (Dec. 10, 1984).	Littleton
Cross-sectional information for bridges on Dad Clark Gulch, (J.F. Sato & Associates, Aug. 14 & 15, 1989).	J.F. Sato

APPENDIX B

COMMUNICATIONS

Kohlenberg

CENTENNIAL ENGINEERING INC

(303) 420-0221 FAX 1-303-420-2308
OFFICE LOCATION: 15000 WEST 64TH AVENUE ARVADA, COLORADO
MAILING ADDRESS: P. O. DRAWER 1307 ARVADA, COLORADO 80001

August 18, 1989

MEETING MINUTES

RE: Lower Dad Clark Gulch and D.F.A. 0068
Outfall Systems Planning and Flood Hazard Area Delineation
CEI - 906.00

DATE HELD: August 9, 1989

LOCATION: Urban Drainage and Flood Control District

PURPOSE: Project Kick-off Meeting #1

PRESENT: See attached attendance list

DISCUSSION

NOTICE: The scheduled August 24 meeting at 9:00 A.M. has been rescheduled to 1:30 P.M. the same day.

1. Barb Benik opened the meeting by asking each project sponser to discuss their specific concerns and what they hope to see as a result. The following comments were made:

   Littleton - Bob Deeds, Fred Bromberger

   - Wants to address water quality issues on Dad Clark Gulch and Jackass Gulch.

   - Development on northeast side of McLellan (peninsula) pumps 2-year storm runoff to Jackass Gulch. Pumping rate was thought to be 50 gpm which is considered negligible.

   - Runoff from the Southpark Business area detention ponds flows into the Highline Canal and is released into Lee Gulch. Would like to look at diverting flow into Jackass Gulch instead. Coordination with Denver Water Department should occur.

- It is Bob's feeling that if detention/water quality ponds are constructed along Jackass Gulch, the existing 48 inch pipe downstream could be made to function for the Q_{100}. The wetland area at the outfall of this pipe should be protected.

- The park-n-ride in lower Jackass Gulch is under construction.

- Southwest Metro Sewer District has line along South Platte River.

UD&FCD - Bill DeGroot

- CWCB is now carefully reviewing FHAD studies. Watch scope of work carefully since they have new regulations.

- Most detention ponds in Highlands Ranch are uncontrolled release behind road embankments. Most are publically owned, maintained and not under state jurisdiction.

- The studies should not recognize non-flood control facilities for baseline hydrology unless adequate insurances are in place. UDFCD would like to see hydrology run with and without flood storage in McLellan Reservoir before deciding whether adequate insurances should be pursued.

- Do not recognize ponds in Rangeview Basin unless they are public-owned and maintained. The Master Plan could look at using ponds for detention if the acquisition is shown in the plan.

- Highline canal will be considered full, thereby accepting no storm runoff.

South Surburban - Diane Schade

- Environmental, recreation, aesthetics.

- South Platte Park - Bald Eagle Nest.

- South surburban maintains Highline Canal Trail. Presently building Mineral Avenue Trail west of Santa Fe. Future connection between the Highline Canal Trail and South Platte Park is planned.

Englewood - Mike Woika

- Keep storm water out of McLellan Reservoir.

- 31 inch discharge pipe from McLellan.

- Mission Viejo owns half of storage which they pump to plant south of C-470.

- Englewood uses City Ditch to convey to Englewood plant. Will be piped in 60 inch conduit in 3 phases.

- Would like to see separation of all drainageways and the City Ditch.

2. Barb would like to meet with CEI to discuss land use, basin delineations, etc., before the CUMP-SWMM modeling proceeds.

3. Future tentative meeting dates and times are as follows:

Thurs, Aug 24	1:30 A.M.
Thurs, Sept 7	9:00 A.M.
Thurs, Sept 21	9:00 A.M.
Thurs, Oct 5	9:00 A.M.
Thurs, Oct 19	9:00 A.M.

All meetings will take place at UD&FCD offices.

4. A list of potential contacts is as follows:

City of Littleton official floodplain coordinator - Jon Payne
Southwest Metro Sewer District - Pat Fitzgerald
KC Ensor - Ira Hardin
CDOH - Ray Aberle
Emkay Developers - Emol Rothlesberger
Denver Water Department -

5. A bar chart project schedule prepared by CEI is attached.

If there are any comments, additions or deletions to these minutes, please notify the undersigned.

CENTENNIAL ENGINEERING, INC.

David L. Mallory

David L. Mallory, P.E.
Project Manager

DLM/vj
Attch.

cc: Attendees

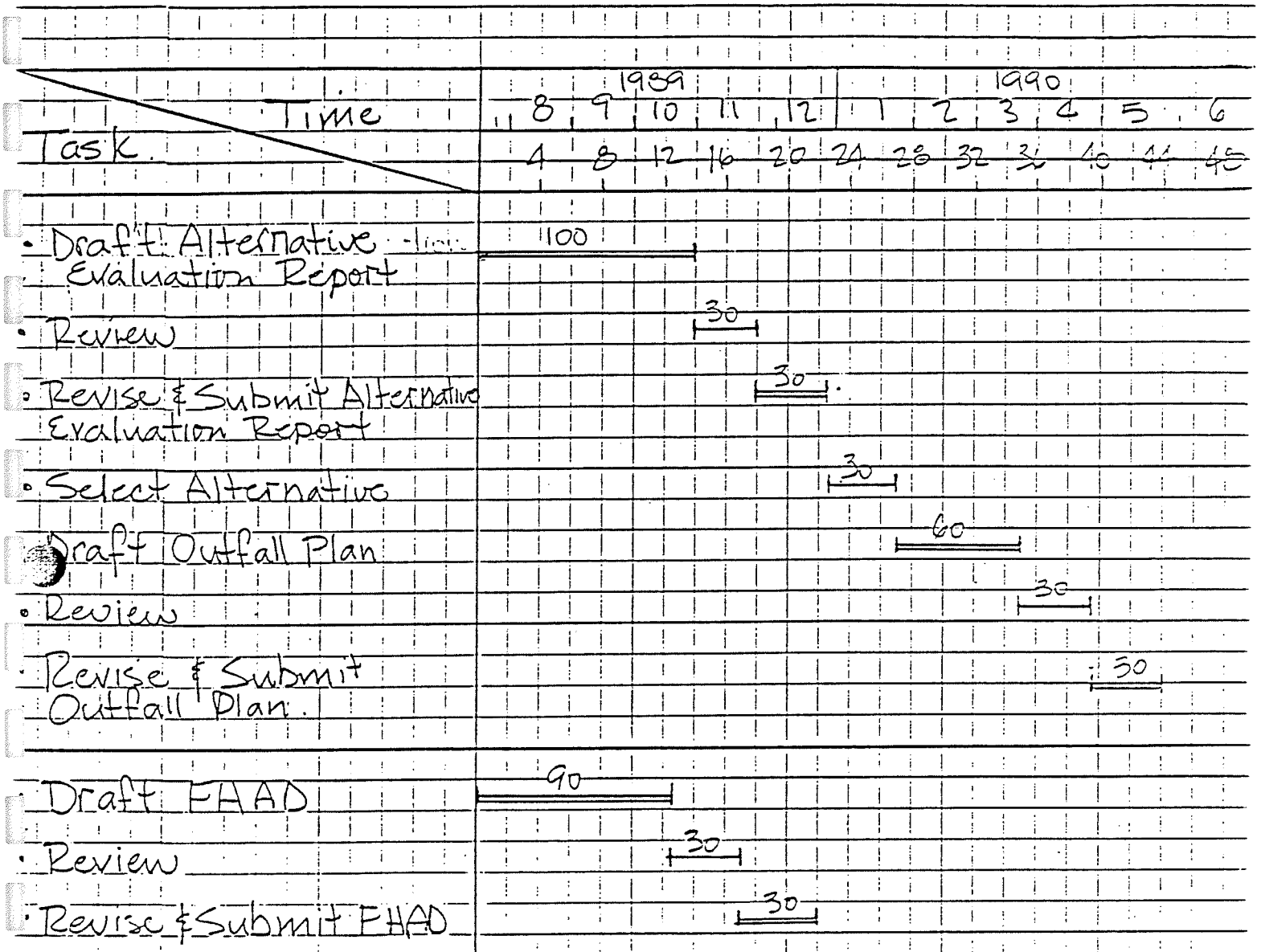
CENTENNIAL ENGINEERING, INC.

Mailing Address: P.O. Drawer 1307, Arvada, Colo 80001
Office Location: 15000 W. 64th Ave., Arvada, Colo. 80004

JOB NO. 906.00 CLIENT UD & FCD DATE 8/9/89

JOB TITLE/SUB-TITLE Dad Clark Gulch & DFA 0065

SUBJECT Schedule. BY DCM CK'D BY



NAME	ORGANIZATION	PHONE
Barbara Bunik	UDFCD	455-6277
Fred Bromberger	Littleton	795-3865
Bob Deeds	City of Littleton	795-3865
Dianne Schade	South Suburban	795-6531
BILL DeGROOT	UDFCD	455-6277
David Mallory	Centennial Engr.	420-0221
BRYAN KOHLENBERG	CENTENNIAL ENG	420-0221
Ben Urbonas	UD&FCD	455-6277
Mike Woika	City of Englewood	761-1140

CENTENNIAL ENGINEERING INC

(303) 420-0221 FAX 1-303-420-2308
OFFICE LOCATION: 15000 WEST 64TH AVENUE ARVADA, COLORADO
MAILING ADDRESS: P. O. DRAWER 1307 ARVADA, COLORADO 80001

August 29, 1989

MEETING MINUTES

RE: Lower Dad Clark Gulch and D.F.A. 0068
Outfall Systems Planning and Flood Hazard Area Delineation
CEI - 906.00
UDFCD Agreement No 89-02.06

DATE HELD: August 25, 1989

LOCATION: Urban Drainage and Flood Control District

PURPOSE: Project Progress Meeting #2

PRESENT: Bob Deeds - City of Littleton
Mike Woika - City of Englewood
Barb Benik - UD&FCD
David Mallory - CEI
Bryan Kohlenberg - CEI

MATERIAL RECEIVED BY CEI TO DATE

1. City of Littleton Generalized Zoning Map (Sept, 1987) and Zoning Regulations (1989).

2. "Final Drainage Study for Southpark Subdivision Filing No. 11, City of Littleton, CO", prepared for the Writer Corporation (Carroll & Lange, Inc., Feb 13, 1987).

3. "Final Drainage Report for Southpark Subdivision Filing, No. 5", prepared for Southpark, A Joint Venture (Merrick & Company, Sept 30, 1981).

4. "Final Drainage Report for Southpark Subdivision Filing No. 1", prepared for Southpark, A Joint Venture (Merrick & Company, April 30, 1981).

5. "Addendum to Final Drainage Report for Southpark Subdivision Filing No. 1", prepared for Southpark, A Joint Venture (Merrick & Company, Oct. 4, 1983).

6. Southpark Pond routing calculations for ponds "C", "E" and "F" for 2, 10, 100 year storms. (Merrick & Company March 3, 1982).

7. "Drainage Study for Southpark Subdivision, City of Littleton, CO" (Tri-Consultants, Feb 1981, Revised June 1981).

8. "Southbridge, Planned Unit Development (THK Associates, Inc., July 23, 1978).

9. "Southbridge Filing No. 1, Littleton, CO, Final Drainage Study" prepared for US Home (Gingery Associates, Inc., Feb 9, 1979).

10. "Southbridge Filing No. 4, Final Drainage Study, Littleton, CO", prepared for US Home, Inc. (Gingery Associates, Inc. June 29, 1981).

11. Drainage Report for Jackass Hill Road SID No. 84-1, Littleton, CO", prepared for City of Littleton (KKBNA, Inc., August 1985).

12. Southpark PD General Plan by Emkay Development, Development plan and standards (sheets 1 and 2 of 6, 1980).

13. Santa Fe Park PD, KC Ensor Realty Co., Conceptual Master Plan and development standards (sheets 1 and 6 of 7, Feb 25, 1985).

14. City of Littleton Storm Drainage Basin Map, Figure 301, enlarged from Drainage Manual.

15. "Major Drainageway Planning, South Platte River, Chatfield Dam to Baseline Road, Phase B - Volume 1", prepared for UD&FCD (Wright Water Engineers, Inc., Nov. 1985).

16. "Flood Hazard Area Delineation, Dad Clark Gulch" prepared for UD&FCD, Douglas County and Mission Viejo Company (Jack G. Raub Company, Nov 1980, revised).

17. "Master Plan of Drainage, Dad Clark Gulch" prepared for Mission Viejo Company (Jack G. Raub Company, Nov 1980 revised, July 1982 revised - w/o maps).

18. "Final Report on the investigation of the 100-year Flood Plan on Dad Clark Gulch across the Santa Fe Park Development" prepared for Hardin & Company (Sillerds & Grigg, Inc., March 1985) including UD&FCD letters to Littleton re: District review for maintenance assistance.

19. "State Engineers Report on McLellan Dam, ID#80225", dated Oct 28, 1983.

20. "Phase I Inspection Report of McLellan Dam, Arapahoe County, CO", City of Englewood, ID# CO01153 (U.S. Army Corps of Engineers, July 1978).

21. "Chapter 10 - Evaluation of Storm Water Treatment Alternatives for McLellan Reservoir", City of Englewood.

22. "Santa Fe Corridor Study Policies" Revised 1988.

23. Santa Fe Drive Corridor Study Zoning Plan", Dec 10, 1984.

24. Littleton City Limits map.

25. 1/4 Section map of Equestrian Park Site at Mineral Ave. and the Highline Canal.

26. South Platte River Park Boundary Map - not including latest land swap with Newton Trust.

27. Santa Fe/South Platte Joint Use Corridor Plan prepared by DHM, Inc. & Urban Edges, Inc. - not dated.

28. Several Culvert Construction Plans throughout Highlands Ranch Area located in the Dad Clark Gulch Basin.

29. Copy of current FEMA Flood Insurance Study Introductory pages, Discharge Table, and Flood Profiles for South Platte River (Arapahoe County, CO) - obtained from UD&FCD, 8/29/89.

Items received from Bob Deeds as a result of this meeting

DISCUSSION

1. Mike Woika asked that items concerning Englewood be discussed first so that he may leave the meeting early.

2. CEI has reviewed the Jack Raub Master Plan Study for Upper Dad Clark Gulch. The historical hydrology was completed without the routing capability of SWMM (i.e. CUHP on the entire basin). Also, old rainfall data was used. However, construction in the basin appears to be in reasonable conformance with the Master Plan.

3. Approximately 800 acres above McLellan Dam (reservoir area and basins immediately south of the reservoir) have not been accounted for the in the Jack Raub study. Since the District does not have SWMM or CUHP computer runs for the Jack Raub study or the unaccounted for basins, CEI may look at

synthesizing hydrographs to determine detention effects of McLellan Reservoir on the Lower Dad Clark Basin. Mike Woika suggested calling John Hendrick at Nolte for J. Raub Report computer runs.

4. CEI would like to see adequate assurance agreements for storm water storage in McLellan pursued up front. Barb will send copy of past agreement to Bob Deeds and Mike Woika.

5. Barb B. would like Ben Urbonas to review our basin delineations. Barb set a meeting for 9am Tuesday, August 28.

6. Bob Deeds would like to see next meeting topics section in meeting minutes to keep limited project sponsors (i.e. Englewood, South Suburban, etc) abreast of issues that might or might not require their attendance. Mike Woika left the meeting at this point.

7. Dave presented CEI's project progress:

   - Field Reconnaissance completed
   - Researched Dad Clark Master Plan by J. Raub
   - Researched McLellan Reservoir studies and reports
   - Contact to CDDH (Ray Aberle) and Highland Ranch Metro District pending return of calls
   - Basin delineations complete for review
   - HEC 2 cross section layout in progress.

8. Rangeview Gulch could outfall into old South Platte channel like Lee Gulch does.

9. Bob mentioned the Santa Fe Park study may have Dad Clark Gulch channel sizing. He will check. Bob doubts detention will be done in Santa Fe Park. Water quality will most likely be accomplished with wet ponds sized to handle a two to five year event.

10. CEI will use either USGS mapping or orthophoto to show basin delineation and routing model for final report. CEI requested the entire mapping at approximately 1"=600" scale but Barb said they would probably not be able to provide it.

11. Sheet layout for FHAD will be plan and profile at 1"=100' scale along the drainageway thalweg. The Outfall Plan will be 1"=200' scale field full plan sheets in a grid pattern covering the entire mapping. CEI should do sheet layouts for both reports and send to UD&FCD along with marked up border sheets. Barb gave CEI blanks of the borders.

12. Dave M. discussed basin delineations. Several sub-basins were found to be direct flow areas to the South Platte and will not be included in the FHAD. Southbridge Filing No. 1 was found to flow historically to the Rangeview Gulch Basin; however, storm sewer improvement route the 100 year flow into a detention pond outletted into Jackass Gulch.

13. Several maps and reports were requested of Bob Deeds some of which he delivered to CEI Friday evening. These are listed above.

14. The September 7 and 21 scheduled meetings are cancelled.

15. A current mailing list of projected sponsors is attached.

Next Meeting - 9am, September 14 at UD&FCD

Items to discuss:

Completed Hydrology
McLellan Reservoir Routing
HEC 2 Cross sections
Outfall System Matrix Alternatives

If there are any comments, additions, or deletions to these minutes, please notify the undersigned.

CENTENNIAL ENGINEERING, INC.

Bryan W. Kohlenberg

Bryan W. Kohlenberg, P.E.
Project Engineer

BWK:rwp
MM_906.00

cc: Mailing List
Doug Weber

LOWER DAD CLARK GULCH AND D.F.A. 0068
OUTFALL SYSTEMS PLANNING
AND
FLOOD HAZARD AREA DELINEATION

MASTER MAILING LIST

UPDATED
AUGUST 25, 1989

Ms. Barbara Benik, P.E. 455-6277
Project Engineer
Master Planning Program
Urban Drainage & Flood Control District
2480 West 26th Avenue, Suite 156B
Denver, Colorado 80211

Mr. Ben Urbonas, P.E. 455-6277
Chief, Master Planning Program
Urban Drainage & Flood Control District
2480 West 26th Avenue, Suite 156B
Denver, Colorado 80211

Mr. Bill DeGroot, P.E. 455-6277
Chief, Flood Plain Management
Urban Drainage & Flood Control District
2480 West 26th Avenue, Suite 156B
Denver, Colorado 80211

Mr. David L. Mallory, P.E. 420-0221
Project Manager
Centennial Engineering Inc.
P.O. Drawer 1307
Arvada, Colorado 80001

Mr. Bryan W. Kohlenberg P.E. 420-0221
Project Engineer
Centennial Engineering Inc.
P.O. Drawer 1307
Arvada, Colorado 80001

Mr. O. Robert Deeds, P.E. 795-3865
Director of Engineering - Utilities
City of Littleton
2255 West Berry Avenue
Littleton, Colorado 80165

Mr. Michael J. Woika, P.E. 761-1140
Utilities Manager
City of Englewood
3400 S. Elati Street
Englewood, Colorado 80110

Ms. Dianne Schade, ASLA 795-6531 x116
Senior Park Planner
South Suburban Park & Recreation District
6315 South University Boulevard
Littleton, Colorado 80121

CENTENNIAL ENGINEERING INC

(303) 420-0221 FAX 1-303-420-2308
OFFICE LOCATION: 15000 WEST 64TH AVENUE ARVADA, COLORADO
MAILING ADDRESS: P. O. DRAWER 1307 ARVADA, COLORADO 80001

August 31, 1989

MEETING MINUTES

RE: Lower Dad Clark Gulch and D.F.A. 0068
Outfall Systems Planning and Flood Hazard Area Delineation
UD&FCD Agreement No. 89-02.06
CEI - 906.00

DATE HELD: August 29, 1989

LOCATION: Urban Drainage and Flood Control District Offices

PURPOSE: Hydrology Concurrence

PRESENT: Ben Urbonas - UD&FCD
Barb Benik - UD&FCD
David Mallory - CEI
Bryan Kohlenberg - CEI

DISCUSSION

This work session was called in order to gain the District's input and concurrence at the project hydrology stage. The following comments and directives were made:

1. Check pond ownership in Southbridge Park Filing 1 (Sub-basin 230). This pond is adjacent to the Highline Canal.

2. Check with Littleton for as built information and capacity of the Southbridge storm sewer system that conveys major storm flows from sub-basin 225 to the pond mentioned above.

3. Sub-basin 010 should be divided into an upper and lower basin at the existing detention pond.

4. As a general policy rule, existing hydrology developed for the OSP study should recognize existing land use and existing drainageway features. Structures that are built specifically for flood control, such as detention facilities and channels (irregardless of ownership), should be included. Irrigation ditches, ponds and impoundments behind road/railroad embankments should be ignored. For future conditions hydrology only those flood control features that are publicly owned and maintained can be recognized. Future conditions hydrology also recognizes future land use as shown in zoning maps. Hydrology for the FHAD is based on future land use and existing channel conditions and only recognizes publicly owned and maintained detention facilities.

5. Based on the foregoing, none of the Rangeview ponds or embankments will be considered for flow attenuation. The detention pond mentioned in Item 1 will be included in the existing condition for the OSP. It will not be recognized in the future conditions hydrology unless it is publicly owned.

6. Sub-basin 135 should be divided to exclude the long narrow strip along Santa Fe Blvd.

If there are any comments, additions, or deletions to these minutes, please notify the undersigned.

CENTENNIAL ENGINEERING, INC.

David Mallory, P.E.
Project Manager

DLM:rwp
MM1_906.00

cc: Bob Deeds
Doug Weber

CENTENNIAL ENGINEERING INC

(303) 420-0221 FAX 1-303-420-2308
OFFICE LOCATION: 15000 WEST 64TH AVENUE ARVADA, COLORADO
MAILING ADDRESS: P. O. DRAWER 1307 ARVADA, COLORADO 80001

September 19, 1989

MEETING MINUTES

RE: Lower Dad Clark Gulch and DFA 0068
Outfall Systems Planning and Flood
Hazard Area Delineation
UD&FCD No. 89-02.06
CEI - 906.00

DATE HELD: September 14, 1989

LOCATION: Urban Drainage and Flood Control District

PURPOSE: Project Progress Meeting #3

PRESENT: UD&FCD - Barb Benik, Bill DeGroot
City of Littleton - Bob Deeds, Fred Bromberger
CEI - David Mallory

DISCUSSION

1. Project hydrology was reviewed. Hydrology is being developed for the following conditions:

   - OSP Existing Conditions: Based on existing development and existing channel conditions. Any facility constructed for the purpose of flood control (public or private) will be included. The effects of irrigation ponds, irrigation ditches, and road embankments will not be included. The effects of McLellan Reservoir will be included.

   - OSP Future Developed Conditions: Based on projected land use, and expected future channel conditions. Only public flood control facilities will be included in the future conditions hydrology. The effects of McLellan Reservior will not be included unless an adequate assurances agreement is in place.

   - FHAD Future Developed Conditions: For this project, the OSP future developed hydrology will be the same as the FHAD future developed.

Based on a review of the South Park Drainage Study, 545 cfs will be released to the Highline Canal during the 100-year event.

Peak 100-year runoff values for the two drainageways, Jackass Gulch and Rangeview Gulch, range between 600 and 700 cfs at the South Platte confluence. Lower Dad Clark Gulch runoff rates are dependent on the outcome of the adequate assurances agreement for McLellan Reservoir.

2. Draft adequate assurances agreements were sent to Englewood and Littleton. Barb will call Mike Woika to coordinate the review and determine a possible approval schedule.

3. The adequacy of the Southbridge 100-year transbasin storm sewer needs to be researched. Fred will supply CEI with as-built drawings if available.

4. The FHAD starting water surface elevation for all three drainageways will be based on the latest FEMA 100-year water surface elevation for the South Platte River. This reach of the South Platte River is controlled by Chatfield Dam releases rather than flood occurrences.

5. The alternative evaluation plans will be presented on 1"=1000' USGS maps. Two 11x17 inch sheets will cover the study area.

6. The evaluation matrix was discussed. The drainageway alternatives will be listed down the left side. Evaluation criteria will be listed across the top. Reach descriptions, alternative components, and evaluation criteria are presented in the attached paper. One alternative for each drainageway should always address floodplain administration with limited channel improvements.

<u>CEI WORK ITEMS</u>

1. Complete hydrology.

2. Complete Upper Dad Clark Gulch Basin review.

3. HEC-2 cross section locations.

4. Sheet layouts for the OSP and FHAD.

5. Title blocks for the OSP and FHAD

6. Outfall systems alternative matrix.

NEXT MEETING

1. The next meeting will be held 10 AM, October 5, 1989, at Centennial Engineering.

2. Since the alternative evaluation matrix is on the agenda for the next meeting, we believe that it will be helpful for the Englewood and South Suburban Park representatives to attend.

   Centennial Engineering is located 1-3/4 miles west of Ward Road at 15000 West 64th Avenue in Arvada. The easiest route is to go west on I-70 to Ward Road, north on Ward Road to 64th Avenue, west on 64th Avenue to Indiana Street. At this point, the road takes a long turn to the north to become Indiana Street. Continue west on 64th Avenue for one more block to Joyce Street. CEI is located in the southwest corner of this tee intersection behind the sign "Arvada Technological Center." The parking lot is off of Joyce Street.

If there are any comments, additions, or deletions to these minutes, please notify the undersigned.

CENTENNIAL ENGINEERING, INC.

David L. Mallory, P.E.
Project Manager

DLM:cs
Attachments
MM\90600.1

cc: Attendees
Mailing List
Bill Wenk
Doug Weber

LOWER DAD CLARK GULCH AND D.F.A. 0068
OUTFALL SYSTEMS PLANNING
AND
FLOOD HAZARD AREA DELINEATION

MASTER MAILING LIST

UPDATED
AUGUST 25, 1989

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LOWER DAD CLARK GULCH AND DFA 0068
UD&FCD NO. 89-02.06
CEI - 906.00

1. REACH DESCRIPTIONS

Rangeview Gulch

- Reach 1.1 - From the confluence with the South Platte River to U/S of the Santa Fe Railroad.

- Reach 1.2 - From U/S of the Santa Fe Railroad to the Highline Canal at the U/S basin limit.

Jackass Gulch

- Reach 2.1 - From the confluence with the South Platte River to the U/S end of the storm sewer at the rail spur located northeast of the Santa Fe/Mineral Boulevard intersection.

- Reach 2.2 - From the U/S end of the storm sewer to the Highline Canal.

- Reach 2.3 - From the Highline Canal along Mineral Avenue to Broadway.

Lower Dad Clark Gulch

- Reach 3.1 - From the confluence with the South Platte River to Santa Fe Boulevard.

- Reach 3.2 - From Santa Fe Boulevard to the McLellan Reservoir Spillway.

2. ALTERNATIVE COMPONENTS

Open channels may be designed for a variety of recurrence intervals. Major drainageways (100-year design) may have trickle or low flow channels or may be wetland bottom as appropriate.

Reach 1.1

- Culvert improvements at the Santa Fe Railroad.

- Open channel D/S of Santa Fe Drive along future river access road. Confluence at the old river channel near Lee Gulch confluence (100-year design).

- Storm sewer or box culvert under the access road.

Reach 1.2

- Detention improvements at Turtle Lake (irrigation pond U/S of Santa Fe Railroad) to include embankment and outlet modifications.
- Relocate City Ditch.
- Open channel or larger storm sewer from Costilla Street to Turtle Lake.
- Improve capacity of storm sewer in Curtice Street.
- Create detention at park pond.

Reach 2.1

- Improve capacity of storm sewer in Mineral Avenue.

Reach 2.2

- Detention at storm sewer inlet.
- Detention at Jackass Hill Road.
- Detention at City park property adjacent to the Highline Canal.
- Aquire detention pond at Southbridge.
- Low flow stabilization in channel with riparian and wetlands protection.
- Full 100 year channel with drop structures.
- Diversion out of Highline Canal.

Reach 2.3

- Increase storm sewer capacity in Mineral Avenue.
- Additional inlet capacity in Mineral Avenue.

Reach 3.1

- Open channel for approved 100-year discharge.
- Continue flow separation at City Ditch.
- Provide dedicated flood storage at McLellan Reservoir.

Reach 3.2

- Open channel for approved 100-year discharge.
- Bridge improvements at Santa Fe Drive.

3. EVALUATION CRITERIA

1. Constructibility: right-of-way, access
2. Cost: Capital and maintenance
3. Flood Control
4. Environmental: aesthetic, recreational, and water quality issues.

DLM:cs
MISC\90600.1

PCM
DCW (X6W
BWK

CENTENNIAL ENGINEERING INC

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OFFICE LOCATION: 15000 WEST 64TH AVENUE ARVADA, COLORADO
MAILING ADDRESS: P. O. DRAWER 1307 ARVADA, COLORADO 80001

October 13, 1989

MEETING MINUTES

RE: Lower Dad Clark Gulch and DFA 0068
Outfall Systems Planning and Flood
Hazard Area Delineation
UD&FCD No. 89-02.06
CEI - 906.00

DATE HELD: October 5, 1989

LOCATION: Centennial Engineering, Inc.

PURPOSE: Project Progress Meeting #~~3~~ 4

PRESENT: UD&FCD - Barb Benik
City of Littleton - Bob Deeds and Fred Bromberger
South Suburban Park & Recreational District - Dianne Schade
CEI - David Mallory

DISCUSSION

1. Project Status:

   - Hydrology - Draft results are available. Final checking will be completed week of October 9, 1989.
   - Upper Basin Hydrology Review - Complete review memo is being transmitted to the project sponsors under separate cover.
   - Alternative Evaluation Matrix - Draft matrix is attached. Alternative evaluation will begin week of October 16, 1989.
   - HEC-2 cross sections, sheet layouts, and title blocks are complete. Cross sections, and sheet layouts will be delivered week of October 9, 1989, after being back checked. Title blocks were delivered at this meeting.

- Agency Coordination - A meeting was scheduled with Pat Gubbins (South Platte Park Manager) for October 10, 1989, 10:00 AM to conduct an on-site review of confluence alternatives. The Denver Water Department will again be contacted for information on the South Park agreement and coordination of flow diversions out of the Highline Canal to Jackass Gulch.

- The updated mailing list is attached to these minutes.

2. Alternative Evaluation Matrix:

Alternative components for each reach of each alternative were discussed. A number of suggestions were made:

- The confluence area at Dad Clark Gulch will require a field review to finalize the alternatives.

- Add a sediment trap (for low flows) at the west property line of Santa Fe Park in the Dad Clark channel (Reach 3.1).

- Consider an increase in storm sewer capacity in Curtice Street (Reach 1.2)

- Consider an interceptor storm sewer for Costilla Street (Reach 1.2).

- On-site detention along Mineral Avenue (Reach 2.3).

The foregoing changes have been made to the attached evaluation matrix. Project participants were requested to review the matrix and return a marked up copy next week indicating other items to be considered. Dianne supplied trail and wetlands information for South Platte Park.

3. Hydrology

Draft hydrology summary tables were distributed and reviewed.

The upper basin hydrology study has been reviewed. The results and recommendations were discussed. Excerpts from the study were distributed.

The following hydrology questions were discussed.

- The existing detention facility in the northeast corner of Mineral Avenue and Santa Fe Drive (Reach 2.2) can be considered a public facility.
- The second detention pond in South Park Filing #4 has been approved for construction. The release rate is 52 cfs.
- Detention was not planned upstream of Jackass Hill Road.
- The drainage plan for South Park Filing #5 has been approved.
- The plan for South Park Filing #11 is as we originally understood it, i.e., 100-year discharge will go to McLellan Reservoir. The 2-year will be detained and pumped to Jackass Gulch.

ITEMS REQUESTED BY CEI:

1. Santa Fe Park PD General Plan.
2. Site specific drainage studies for Reach 2.3
3. Coordination with Englewood on the adequate assurances agreement for McLellan Reservoir.
4. Ridgeview Park Master Plan.
5. Review of draft alternative evaluation matrix.
6. Review of Dad Clark upper basin recommendations.

CEI WORK ITEMS

1. Finalize hydrology.
2. Deliver cross sections and sheet layouts.
3. Begin alternative evaluation.
4. Contact Littleton traffic engineering for details of river access road.

5. Contact Denver Water Department regarding Highline Canal issues.

6. Consult with Bill Wenk, wetlands subconsultant.

7. Coordinate confluence issues with South Suburban Parks.

NEXT MEETING

The next meeting will be held October 19, 1989 at Centennial Engineering.

If there are any comments, additions, or deletions to these minutes, please notify the undersigned.

CENTENNIAL ENGINEERING, INC.

David L. Mallory, P.E.
Project Manager

DLM:cs
Attachments
MM\90600.2

LOWER DAD CLARK GULCH AND DFA 0068
UD&FCD Project No. 89-02.06
CEI -90600

October 13, 1989

ALTERNATIVE EVALUATION MATRIX FOR OUTFALL SYSTEMS PLANNING STUDY

ALTERNATIVE 1

- *Reach 1.1* - Open channel along future river access road for Q(100). Discharge in old river channel near Lee Gulch. Culvert improvements at AT&SF rail line. Culverts to drain Basin 140.

- *Reach 1.2* - Embankment, outlet, and spillway improvements to direct Turtle Lake discharges west to culverts under the rail lines and Santa Fe Drive. Relocate City Ditch. Open channel between Turtle Lake and Costilla Street. Increase storm sewer capacity in Curtice Street. Inlet improvements at Ridgeview Park. Channel rehabilitation and limited roadway culvert improvements upstream of park.

- *Reach 2.1* - No improvements to 60" storm sewer or confluence area in South Platte Park. New 60" storm sewer (Capacity = 500 cfs) increased 500 cfs.

- *Reach 2.2* - Detention at storm sewer inlet area to attenuate Q(100) to the storm sewer capacity of ~~170~~ cfs. Detention upstream of Jackass Hill Road to reduce Q(100) to existing culvert capacity. Low flow channel stabilization to include low head drops and wetlands mitigation.

- *Reach 2.3* - No improvements to existing storm sewers or other detention features.

- *Reach 3.1* - Grass-lined channel designed for Q(100) = 1850 cfs. Continue flow separation at City Ditch. Provide a sedimentation pond at the west boundary of Santa Fe Park sized to detain frequent runoff events developed in the lower basin. Continue low flow channel across South Platte Park while the major channel transitions to nothing.

- *Reach 3.2* - Grass-lined channel designed for Q(100) = 1850 cfs.

ALTERNATIVE 2

- *Reach 1.1* - Open channel and culvert improvements as proposed in Alternative 1. Q(100) will be lower due to upstream detention.

- *Reach 1.2* - Embankment and City Ditch relocation as proposed in Alternative 1. Provide municipal detention (with a permanent pool) at Turtle Lake to reduce

downstream flows. Open channel between Turtle Lake and Costilla Street and storm sewer improvements in Curtice Street as proposed in Alternative 1. Provide an interceptor storm sewer in Costilla Street to divert flows into Turtle Lake before they reach the low point in Costilla Street. Inlet, channel, and roadway culvert improvements at Ridgeview Park as proposed in Alternative 1.

- *Reach 2.1* - As proposed in Alternative 1.

- *Reach 2.2* - Detention as proposed in Alternative 1. Low flow stabilization as proposed in Alternative 1. Diversion out of the Highline Canal with detention at City park property to reduce release flows to existing downstream channel capacity.

- *Reach 2.3* - Recognize existing and proposed storm sewer and detention facilities.

- *Reach 3.1* - Grass-lined channel designed for Q(100) = 850 cfs. Continued flow separation at City Ditch. Sedimentation pond and South Platte Park channel as proposed in Alternative 1.

- *Reach 3.2* - Grass-lined channel designed for Q(100) = 850 cfs. Execute an adequate assurances agreement for flood storage at McLellan Reservoir.

ALTERNATIVE 3

- *Reach 1.1* - Open channel and culvert improvements as proposed in Alternatives 1 and 2. Q(100) will be lower than Alternatives 1 and 2 due to increased upstream detention.

- *Reach 1.2* - Provide for embankment improvements, City Ditch relocation, and municipal flood storage at Turtle Lake as proposed in Alternative 2. Provide for municipal flood storage at Ridgeview Park to reduce Q(100) releases to an amount that can be conveyed in the existing Curtice Street storm sewer with residual street flow. Storm sewer and/or open channel between Turtle Lake and Costilla Street. Interceptor storm sewer in Costilla Street as proposed in Alternative 2. Channel rehabilitation and roadway culvert improvements upstream of Ridgeview Park.

- *Reach 2.1* - As proposed in Alternatives 1 and 2.

- *Reach 2.2* - As proposed in Alternative 2.

- *Reach 2.3* - Provide municipal flood storage and storm sewer improvements along Mineral Avenue. Municipal flood storage at existing Southbridge detention facility.

- *Reach 3.1* - Wetlands bottom channel designed for lower Q(100) = 850 cfs through Santa Fe Park and South Platte Park. Continue flow separation at City Ditch.

- *Reach 3.2* - Grass-lined channel designed for lower Q(100) = 850 cfs. Execute an adequate assurances agreement for flood storage at McLellan Reservoir.

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LOWER DAD CLARK GULCH AND D.F.A. 0068
OUTFALL SYSTEMS PLANNING
AND
FLOOD HAZARD AREA DELINEATION

MASTER MAILING LIST

UPDATED
SEPTEMBER 20, 1989

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LOWER DAD CLARK GULCH AND DFA 0068
UD&FCD Project No. 89-02.06
CEI - 90600

October 5, 1989

ALTERNATIVE EVALUATION MATRIX FOR OUTFALL SYSTEMS PLANNING STUDY

ALTERNATIVE 1

- *Reach 1.1* - Open channel along future river access road for Q(100). Discharge in old river channel near Lee Gulch. Culvert improvements at AT&SF rail line. Culverts to drain Basin 140.

- *Reach 1.2* - Embankment, outlet, and spillway improvements to direct Turtle Lake discharges west to culverts under the rail lines and Santa Fe Drive. Relocate City Ditch. Open channel between Turtle Lake and Costilla Street. Inlet improvements at Ridgeview Park. Channel rehabilitation and limited roadway culvert improvements upstream of park.

- *Reach 2.1* - No improvements to 60" storm sewer or confluence area in South Platte Park.

- *Reach 2.2* - Detention at storm sewer inlet area to attenuate Q(100) to the storm sewer capacity of 170 cfs. Detention upstream of Jackass Hill Road to reduce Q(100) to existing culvert capacity. Low flow channel stabilization to include low head drops and wetlands mitigation.

- *Reach 2.3* - No improvements to existing storm sewers or other detention features.

- *Reach 3.1* - Grass-lined channel designed for Q(100) = 1850 cfs. Continue flow separation at City Ditch.

- *Reach 3.2* - Grass-lined channel designed for Q(100) = 1850 cfs.

ALTERNATIVE 2

- *Reach 1.1* - Open channel and culvert improvements as proposed in Alternative 1. Q(100) will be lower due to upstream detention.

- *Reach 1.2* - Embankment and City Ditch relocation as proposed in Alternative 1. Provide municipal detention (with a permanent pool) at Turtle Lake to reduce downstream flows. Open channel between Turtle Lake and Costilla Street as proposed in Alternative 1. Inlet, channel, and roadway culvert improvements at Ridgeview Park as proposed in Alternative 1.

What is capacity of S+S in Reach 2.3

- *Reach 2.1* - As proposed in Alternative 1.
- *Reach 2.2* - Detention as proposed in Alternative 1. Low flow stabilization as proposed in Alternative 1. Diversion out of the Highline Canal with detention at City park property to reduce release flows to existing downstream channel capacity.
- *Reach 2.3* - As proposed in Alternative 1.
- *Reach 3.1* - Grass-lined channel designed for Q(100) = 850 cfs. Continued flow separation at City Ditch.
- *Reach 3.2* - Grass-lined channel designed for Q(100) = 850 cfs. Execute an adequate assurances agreement for flood storage at McLellan Reservoir.

ALTERNATIVE 3

- *Reach 1.1* - Open channel and culvert improvements as proposed in Alternatives 1 and 2. Q(100) will be lower than Alternatives 1 and 2 due to increased upstream detention.
- *Reach 1.2* - Provide for embankment improvements, City Ditch relocation, and municipal flood storage at Turtle Lake as proposed in Alternative 2. Provide for municipal flood storage at Ridgeview Park to reduce Q(100) releases to an amount that can be conveyed in the existing storm sewer with residual street flow. Storm sewer and/or open channel between Turtle Lake and Costilla Street. Channel rehabilitation and roadway culvert improvements upstream of Ridgeview Park.
- *Reach 2.1* - As proposed in Alternatives 1 and 2.
- *Reach 2.2* - As proposed in Alternative 2.
- *Reach 2.3* - Storm sewer, inlet, and detention improvements along Mineral Avenue. Municipal flood storage at existing Southbridge detention facility.
- *Reach 3.1* - Wetlands bottom channel designed for lower Q(100) = 850 cfs. Continue flow separation at City Ditch.
- *Reach 3.2* - Grass-lined channel designed for lower Q(100) = 850 cfs. Execute an adequate assurances agreement for flood storage at McLellan Reservoir.

Look @ inlets & storm sewer to pick up discharge in Costilla before C.P.

include a ft increased storm sewer in Roosevelt

DLM:cs
Reports\90600.1

CENTENNIAL ENGINEERING INC

(303) 420-0221 FAX 1-303-420-2308
OFFICE LOCATION: 15000 WEST 64TH AVENUE ARVADA, COLORADO
MAILING ADDRESS: P. O. DRAWER 1307 ARVADA, COLORADO 80001

October 30, 1989

MEETING MINUTES

RE: Lower Dad Clark Gulch and DFA 0068
Outfall Systems Planning and Floor Hazard Area Delineation
UD & FCD No. 89-02.06

DATE HELD: October 19, 1989

LOCATION: Centennial Engineering, Inc.

PURPOSE: Project Progress Meeting #5

PRESENT: UD & FCD - Barb Benik
City of Littleton - Fred Bromberger
CEI - David Mallory

DISCUSSION

1. Project Status

- HEC-2 cross sections, sheet layouts, and upper Dad Clark basin hydrology review are now complete and delivered.
- Hydrology has been revised to reflect the effects of existing detention in the upper Jackass Gulch basin. Hydrology material will be delivered for UD & FCD review the week of October 30, 1989.
- Alternative evaluation began the week of October 16, 1989.
- FHAD work is expected to begin the week of November 6, 1989 when the HEC-2 cross sections are delivered.

2. Contacts

- Bob Schroeder, Denver Water Department (DWD) is receptive to the idea of diversions out of the Highline Canal during storm events. The diversion structure should be automatic in nature, such as a side delivery siphon or spillway.

- Dick Hovercamp, City of Littleton. River access road will probably be a single lane gravel road to provide CWCB maintenance access to the South Platte River channel. Only enough right-of-way will be condemned for that purpose.

- Pat Gubbins, South Suburban Park and Recreation District. A site meeting was held to discuss confluence alternatives for Dad Clark Gulch. The results of the meeting are reflected in the revised alternatives (attached).

3. McLellan Reservoir

No movement can be reported on the adequate assurances agreement for flood storage at the reservoir. In addition, UD & FCD has directed CEI to develop multi-frequency discharges for lower Dad Clark Gulch (only 100-yr. discharges are currently available for the upper Dad Clark basin). CEI will accomplish the task in the following manner:

- The effect of McLellan Reservoir will be ignored for the existing and developed conditions. Flood storage will still be considered as a planning alternative.

- The eight upper basin hydrographs will be combined and routed through an assumed channel in place of the reservoir.

- The ratio of 2-, 5-, 10- and, 50-year peak flows to 100-year peak flows for upper basin hydrographs will be similar to the ratios observed previously in the CUHP evaluation.

- No distinction will be made between existing and developed conditions for the upper basin.

4. Alternatives

The following components have been added to the alternatives and are reflected in the revised alternative evaluation matrix:

- Convey Rangeview Gulch from Turtle Lake north along the east side of the AT & SE Railroad to a point directly east of the future river access road (Reach 1.1).

- Increased storm sewer capacity in Reach 2.1.

- Incorporate private detention in Reach 2.3.

- Pipe alternative across South Platte Park in Reach 3.1.

Item Requested by CEI

1. Utility maps for Littleton sanitary and storm sewer.

CEI Work Items

1. Deliver hydrology package for review.
2. Develop unit cost data.
3. Continue alternative analysis development.

Next Meeting

The next meeting will be held at 9:00 am on November 9, 1989 at Centennial Engineering.

If there are any comments, additions, or deletions to these minutes, please notify the undersigned.

CENTENNIAL ENGINEERING, INC.

David Mallory

David Mallory, P.E.
Project Manager

DM:rl
Attachments
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cc: LDCG Mailing List

LOWER DAD CLARK GULCH AND D.F.A. 0068
OUTFALL SYSTEMS PLANNING
AND
FLOOD HAZARD AREA DELINEATION

UD&FCD No. 89-02.06
CEI 906.00

Master Mailing List
Updated
October 24, 1989

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LOWER DAD CLARK GULCH AND DFA 0068
UD&FCD Project No. 89-02.06
CEI -90600

October 27, 1989

ALTERNATIVE EVALUATION MATRIX FOR OUTFALL SYSTEMS PLANNING STUDY

ALTERNATIVE 1

- *Reach 1.1* - Open channel along future river access road for Q(100). Discharge in old river channel near Lee Gulch. Culvert improvements at AT&SF rail line. Culverts to drain Basin 140.

- *Reach 1.2* - Embankment, outlet, and spillway improvements to direct Turtle Lake discharges west to culverts under the rail lines and Santa Fe Drive. Relocate City Ditch. ~~Open channel~~ between Turtle Lake and Costilla Street. Increase storm sewer capacity in Curtice Street. Inlet improvements at Ridgeview Park. Channel rehabilitation and limited roadway culvert improvements upstream of park.

- *Reach 2.1* - New 60" storm sewer in parallel with existing 60" storm sewer. Conveyance capacity increased from 260 cfs to 520 cfs. Enlarge existing open channel across South Platte Park.

- *Reach 2.2* - Increase existing detention at storm sewer inlet area to attenuate Q(100) to the increased storm sewer capacity of 520 cfs. Detention upstream of Jackass Hill Road to reduce Q(100) to existing culvert capacity. Low flow channel stabilization to include low head drops and wetlands preservation/mitigation.

- *Reach 2.3* - No improvements to existing storm sewers or other detention facilities.

- *Reach 3.1* - Grass-lined channel designed for Q(100) = ~~1900~~ 1800 cfs. Continue flow separation at City Ditch. Provide a sedimentation pond at the west boundary of Santa Fe Park sized to detain frequent runoff events developed in the lower basin. Convey low flows across South Platte Park in the existing ditch and new storm sewer. Major channel transitions to nothing at park boundary.

- *Reach 3.2* - Grass-lined channel designed for Q(100) = ~~1900~~ 1800 cfs.

ALTERNATIVE 2

- *Reach 1.1* - Open channel and culvert improvements as proposed in Alternative 1. Q(100) will be lower due to upstream detention.

- *Reach 1.2* - Embankment and City Ditch relocation as proposed in Alternative 1. Provide municipal detention (with a permanent pool) at Turtle Lake to reduce downstream flows. Open channel between Turtle Lake and Costilla Street and storm sewer improvements in Curtice Street as proposed in Alternative 1. Provide an interceptor storm sewer in Costilla Street to divert flows into Turtle Lake before they reach the low point in Costilla Street. Inlet, channel, and roadway culvert improvements at Ridgeview Park as proposed in Alternative 1.

- *Reach 2.1* - No improvements to existing 60" storm sewer or South Platte Park channel.

- *Reach 2.2* - Increase existing detention at storm sewer inlet area to attenuate Q(100) to the existing storm sewer capacity of 260 cfs. Low flow stabilization as proposed in Alternative 1. Diversion out of the Highline Canal with detention at City park property to reduce release flows to existing downstream channel capacity.

- *Reach 2.3* - Recognize existing and proposed storm sewer and detention facilities.

- *Reach 3.1* - Grass-lined channel designed for Q(100) = 850 cfs. Continued flow separation at City Ditch. Sedimentation pond and major channel transition as proposed in Alternative 1. New low flow channel with maintenance access across South Platte Park.

- *Reach 3.2* - Grass-lined channel designed for Q(100) = 850 cfs. Execute an adequate assurances agreement for flood storage at McLellan Reservoir.

ALTERNATIVE 3

- *Reach 1.1* - Open channel to convey Q(100) Turtle Lake outflows north along the east side of the AT & SF rail line. New crossing structures under rail lines and Santa Fe Drive. Storm sewer in river access road and open channel to old river channel near Lee Gulch.

- *Reach 1.2* - Provide for embankment improvements, City Ditch relocation, and municipal flood storage at Turtle Lake as proposed in Alternative 2. Provide for municipal flood storage at Ridgeview Park to reduce Q(100) releases to an amount that can be conveyed in the existing Curtice Street storm sewer with residual street flow. Storm sewer and/or open channel between Turtle Lake and Costilla Street. Interceptor storm sewer in Costilla Street as proposed in Alternative 2. Channel rehabilitation and roadway culvert improvements upstream of Ridgeview Park.

- *Reach 2.1* - As proposed in Alternative 2.

- *Reach 2.2* - As proposed in Alternative 2.

- *Reach 2.3* - Provide municipal flood storage and storm sewer improvements along Mineral Avenue. Municipal flood storage at existing Southbridge detention facility.

- *Reach 3.1* - Wetlands bottom channel designed for lower Q(100) = 850 cfs through Santa Fe Park. Continue flow separation at City Ditch. Wetlands bottom low flow channel and major channel transition at South Platte Park.

- *Reach 3.2* - Grass-lined channel designed for lower Q(100) = 850 cfs. Execute an adequate assurances agreement for flood storage at McLellan Reservoir.

DLM:cs
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CENTENNIAL ENGINEERING INC

(303) 420-0221 FAX 1-303-420-2308
OFFICE LOCATION: 15000 WEST 64TH AVENUE ARVADA, COLORADO
MAILING ADDRESS: P. O. DRAWER 1307 ARVADA, COLORADO 80001

November 20, 1989

MEETING MINUTES

RE: Lower Dad Clark Gulch & DFA 0068
Outfall Systems Planning and Flood Hazard Area Delineation
UD&FCD No. 89-02.06
CEI - 906.00

DATE HELD: November 15, 1989

LOCATION: CEI Conference Room

PURPOSE: Project Progress Meeting #6

PRESENT: UD&FCD: Barb Benik, City of Littleton: Bob Deeds,
CEI: David Mallory

DISCUSSION

1. Project Status

   - Preliminary alternative evaluation hydraulic calculations are complete.
   - Draft alternative evaluation report is in progress.
   - Cross section data is expected the week of November 20, 1989.
   - District review and approval of hydrology is expected the week of November 20, 1989.
   - Draft adequate assurances agreement is currently being reviewed by Littleton.
   - Change order No. 1 is being processed by the District.

2. Contacts

   - Gil Martinez of DWD explained that the Highline Canal wasteways are located at Plum Creek, Marcy Gulch, Dad Clark Gulch, and Lee Gulch. They generally open all the gates during a storm event. DWD has some debris and maintenance concerns with the syphon option. DWD has built a side delivery spillway in Waterton Canyon.

3. Alternatives

   The following changes were requested:

   - Rangeview Gulch - consider a channel south of the river access instead of closed conduit in the road. Use a combination of storm sewer and street flow (or swale) for 100-year events.

   - Jackass Gulch - consider open channel west to South Platte River or south to Dad Clark Gulch instead of second 60" RCP in Mineral Avenue. Consider diverting the 100-year contribution from South Park (545 cfs) into McLellan Reservoir in addition to proposed diversion of 300 cfs into Jackass Gulch.

4. Floodplain Extra

   Two floodplains will be required for Lower Dad Clark Gulch reflecting the with and without McLellan Reservoir conditions. Floodway analysis and hydrology will also be required.

5. Unit Costs

   Unit cost tables were distributed for review.

ITEMS REQUESTED BY CEI

1. Side delivery spillway plans and cost data from DWD (CEI will coordinate with DWD).

CEI WORK ITEMS

1. Deliver draft alternative evaluation report for review.

2. Begin Hec-2 analysis the week of November 27, 1989.

NEXT MEETING

The next meeting has not been scheduled. An oral presentation will be scheduled during the alternative review period.

If there are any comments, additions, or deletions to these minutes, please notify the undersigned.

CENTENNIAL ENGINEERING, INC.

David Mallory, P.E.
Project Manager

DLM:rl
Attachment
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cc: Mailing List

LOWER DAD CLARK GULCH AND D.F.A. 0068
OUTFALL SYSTEMS PLANNING
AND
FLOOD HAZARD AREA DELINEATION

UD&FCD No. 89-02.06
CEI 906.00

Master Mailing List
Updated
October 24, 1989

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Mr. Bob Schroeder
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Denver Water Department
Denver, CO 80254
628-6382

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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

L. Scott Tucker, Executive Director

November 28, 1989

Mr. David Mallory
Centennial Engineering, Inc.
Post Office Drawer 1307
Arvada, Colorado 80001

Subject: Lower Dad Clark Gulch Outfall Systems
Planning and Flood Hazard Area Delineation

Dear David:

We have reviewed the Hydrology Technical Addendum to the Alternative Evaluation Report for the subject study. Your calculations appear to be quite thorough. The hydrology you have developed for this study is hereby approved.

Sincerely,

Ben Urbonas, P.E.
Chief, Master Planning Program

Barbara Benik

By: Barbara Benik, P.E.
Project Engineer
Master Planning Program

BRU/BB/gb

TELEPHONE 455-6277 · SUITE 156 B · 2480 W. 26TH AVENUE · DENVER, COLORADO 80211

MEMORANDUM

Date: December 19, 1989

To: Dave Mallory, Centennial Engineering

From: Bill Wenk, William Wenk Associates

Subject: Rangeview Drainageway, Jackass & Dad Clark Gulches; Arapahoe County

In response to your request and as a result of a site visit to the drainageways conducted with you on December 14th, I'm providing the following comments concerning engineering master plan proposals prepared by Centennial for the drainageways. Currently, all the drainageways are providing wildlife habitat, recreation, and open space amenities to the surrounding community. Consequently, all are sensitive, to varying degrees, to changes that will result from channel improvements. Although the engineering improvements proposed seem appropriate in all cases, changes will have a negative impact on the visual qualities of the channels, will disrupt the existing wildlife habitat, and could compromise the existing and potential recreation uses there. The degree of impact will depend on the care taken during final design to identify the resource and to minimize the impact.

The preferred stategy to minimize impacts should be to avoid disturbance of the existing resources. Prior to beginning final design, existing resources should be identified, their significance prioritized, and engineering improvements designed to avoid them. For example, large trees along Jackass Gulch provide important habitat, as do woody shrub masses. Given their maturity, they are more important than herbaceous wetlands and should be a priority for preservation. Timing is also a key to avoidance. Construction work and related disruptions should be scheduled to avoid nesting seasons in critical habitat areas.

If disturbance or destruction of existing resources is unavoidable, their loss should be mitigated as part of channel improvements. The range of mitigation would probably include reestablishment and enhancement of wetlands and wildlife habitat lost; mitigation of visual impacts of channel structures by coloring, texturing, and/or integration of structures into site grading work; and the special design of channels and structures to maintain or enhance existing or proposed recreation areas.

Following is a list of key concerns for each drainageway, and potential avoidance or mitigation measures that should be taken as a part of final design.

JACKASS GULCH

Key Concerns:

1. Jackass Gulch is highly visible from Mineral Avenue. It is lined with a diverse, high quality wetlands from Mineral Avenue to Sante Fe Drive, and through South Platte Park to its confluence with the South Platte River. The proposed series of detention ponds and the drop structures could significantly alter the character of the existing drainageway and could require mitigation in response to Federal 404 permit requirements.

Avoidance and Mitigation Measures:

1. Existing wetlands and reparian areas should be mapped to allow location of drop structures and detention embankments that avoid the most valuable areas of habitat.

2. Detention embankments should be graded to blend with the adjacent slopes to minimize visual impacts. Avoid straight-line, trapezoidal sections, steep embankments, visible structures, and difficult to maintain slopes. To the degree possible, match the steepness of adjacent side slopes.

3. To maintain existing wetland and riparian vegetation maintain the flow line and rate of the existing low flow channel, and avoid disruption of the existing water table.

4. Coordinate channel improvements with development proposals for the adjacent land use, especially if passive recreation uses are proposed for the channel.

5. Complete a visual analysis to identify highly visible areas. Specially design structures in highly visible areas to allow maximum integration into the landscape. Optimally, structures would be buried riprap or similar permeable structures that can be buried and that allow grass cover.

RANGEVIEW DRAINAGEWAY

Key Concerns:

1. Since the basin is fully developed with existing parks and residences, all improvements should be designed to allow for minimum disruption of existing resources, especially those in the small park.

2. Channel construction in South Platte Park should be done with great care to avoid disruption of existing wildlife habitat, and to integrate improvements with the existing natural features.

Avoidance and Mitigation Measures:

1. The levee in the small park should be designed to avoid filling over the root zone of the large cottonwood trees. Maximum slopes should be 4:1 to allow turf grass maintenance, and turfgrass should be reestablished.

2. Inlet and headwall structures in the park should be designed to be minimally visible from adjacent residential areas and/or screened with plant materials if visability is unavoidable.

3. Integrate the proposed open channel into South Platte Park. Vary the channel cross section to allow integration into the existing land form; vary the channel cross section to allow creation of diverse wetlands and riparian areas. Consider design of a level spreader at the edge of existing riparian areas to preclude the development of defined channels, and to spread storm waters uniformly over a wide area.

DAD CLARK GULCH:

Key Concerns:

1. Construction of the low flow channel in South Platte Park may have some significant visual and ecological impacts.

2. Construction of an open channel through the residential area directly below McClellan Reservoir may have significant impacts on large trees, and the natural setting of the existing homes.

Avoidance and Mitigation Measures:

1. Minimize the disruption of channel construction in South Platte Park. Vary the channel cross section and alignment to blend with the existing topography. Consider construction of a level spreader below the proposed water quality pond to avoid construction of a defined channel.

2. Locate existing wetlnads and riparian areas, route channel through least sensitive area.

3. Design structures in South Platte Park to be minimally visible. Bury structures, or color or texture them to diminish visability.

4. Carefully align the channel between the McClellan embankment and Sante Fe Drive to avoid loss of existing trees, to minimize impacts on existing residential uses, and to minimize visability of the channel from the homes.